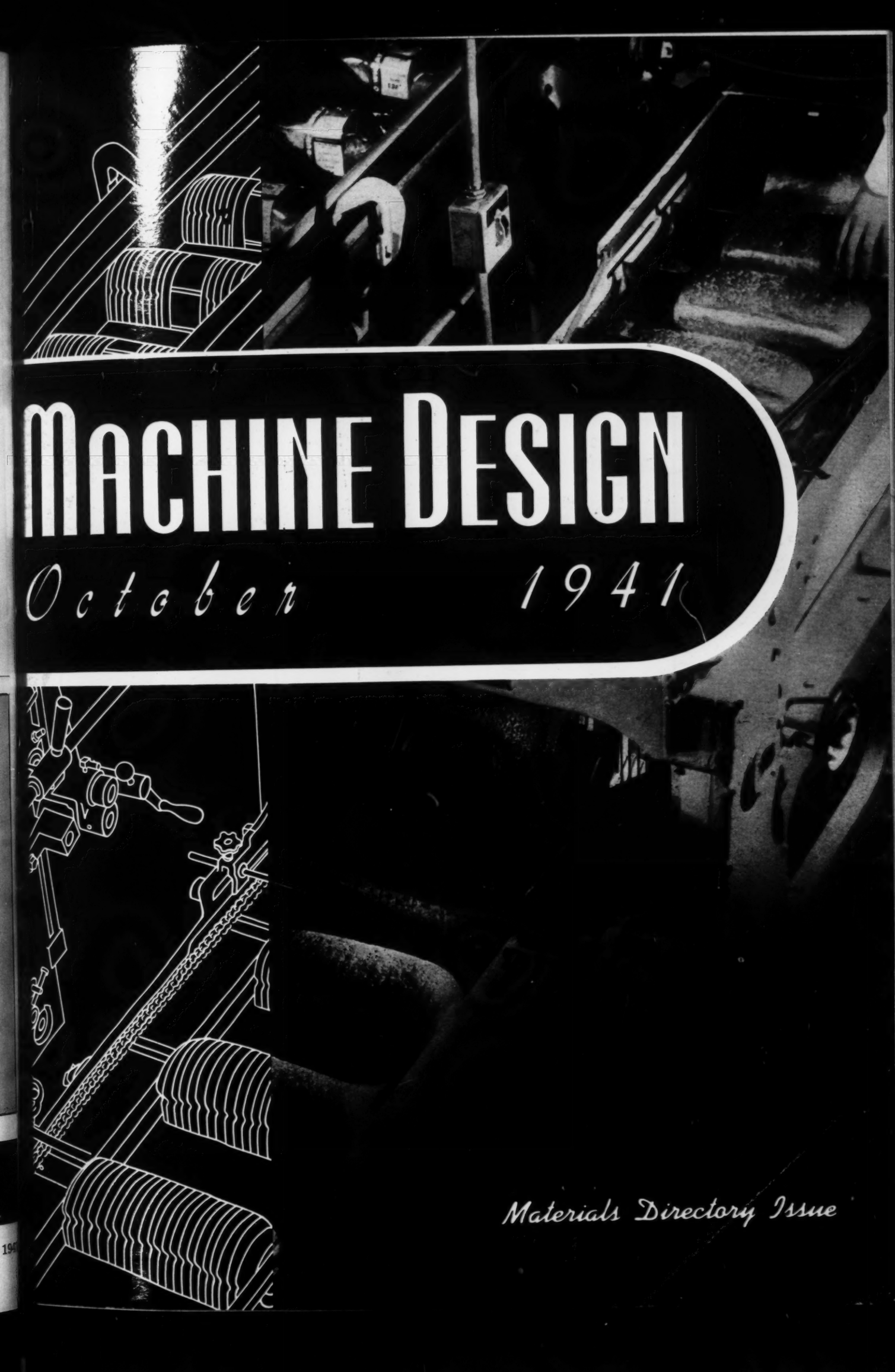


# MACHINE DESIGN

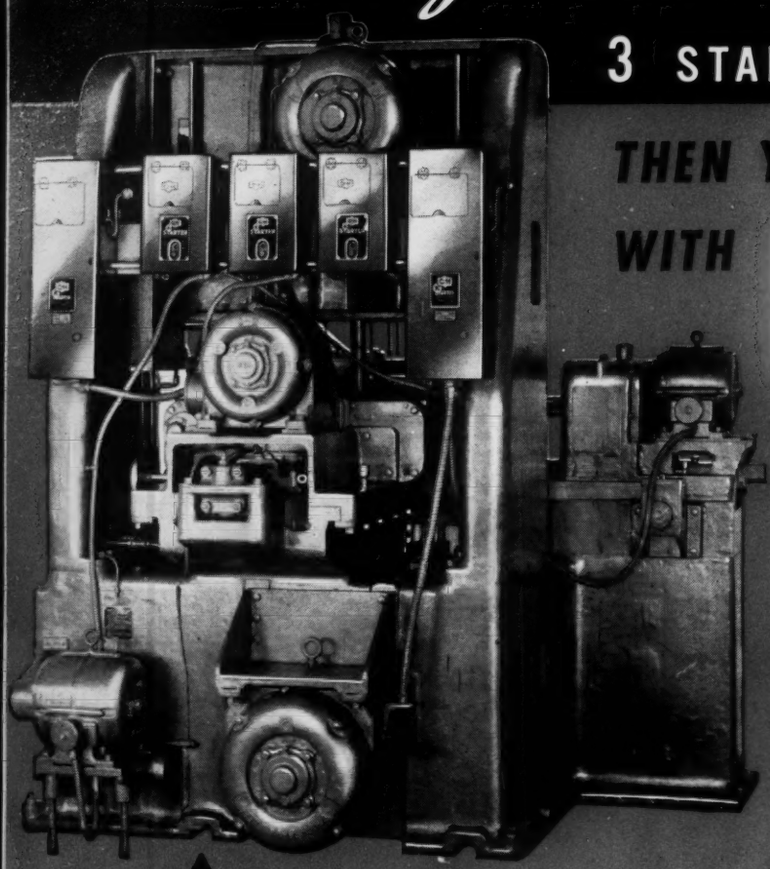
October 1941

Materials Directory Issue

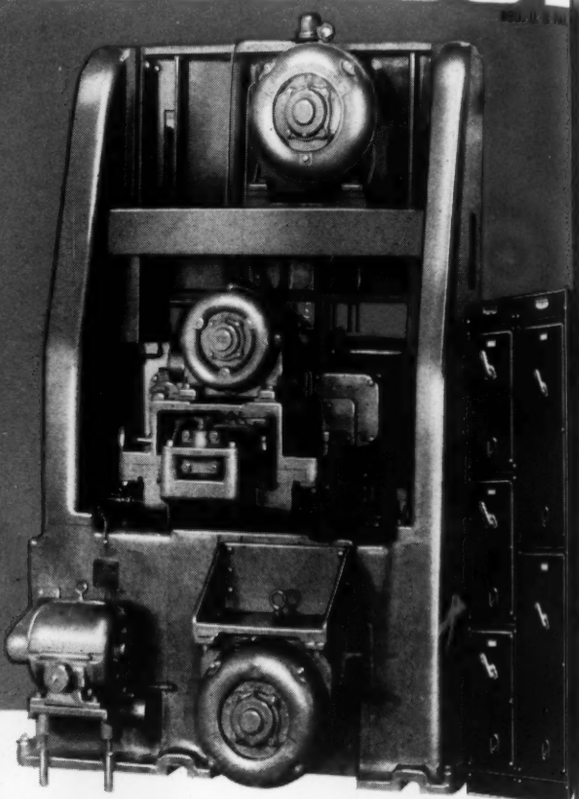
# What do you need for your plant—

## 3 STARTERS OR 300 STARTERS?

## THEN YOU ARE VITALLY CONCERNED WITH UNITROL



**NOT THIS:** It's a lot of work to hang needed controls on a machine . . . or to install them individually nearby. Bulky, inconvenient, space-wasting, costly to assemble and install.



**BUT THIS:** The same number of Controls takes up little space in a section or two of Unitrol nearby. And it's easy to construct, ship, install, and inspect control when it's built into Unitrol.

### 1st . . . . The Unitrol Unit

The basic element of Unitrol is a simple unit mounting-frame into which any standard control device may be bolted. This unit frame has integral with it a hinged cover or door which may be blank, or arranged for either dead-front manual or push-button operation of the device enclosed.

### 2nd . . . The Unitrol Section

is a steel enclosure which houses and supports a group of Unitrol Units. It is constructed of standardized interchangeable members to form the sides, top and back . . . with unique provisions for bus supports, wiring troughs, conduit or duct entrances, etc.

### 3rd . . . The Unitrol Control Center

consists of a grouping of Unitrol Sections fabricated into a complete sectionalized assembly and delivered ready for installation and use.

**Unitrol is the next step forward in Motor Control Practice. But it offers so many advantages that you cannot afford to wait until you are ready to "modernize." Unitrol may have the answer to the problem that has "stopped" you *right now.***

You are invited to bear in mind conditions that face your plant right now, as you read about Unitrol. Unitrol is a new method of housing and installing conventional starters.

The first step is the new Unitrol single unit mounting frame, into which any one of several sizes of conventional starters or control elements can be mounted. The second step is the new Unitrol Sectional frame into which several *unit* controls in *their* frames can be installed. The whole section thus forms a completely enclosed, compact and accessible structure which can be located anywhere, near a machine, against a wall, in a corner and so on. The third step is the Unitrol Control Center composed of more than one section; it is as complete as you want it, extensible, flexible, actually custom-built to your specific and individual needs.

There is no other method of housing and mounting a number of starters as compactly as Unitrol. There is no other method of custom-building a complete motor control center to your individual needs as easily and economically as Unitrol. There is no method as flexible or as interchangeable as Unitrol. Its ability to save space is remarkable. It may eliminate a need in your plant to build plant extensions. It may prove to be just the type of control organization in your plant needed to break a "bottleneck." It grows in size or it contracts in size to keep abreast of your needs. The control elements housed in it may be changed at will, and easily. Its installation requires no special wall or floor preparation. Literally, it can be installed anywhere. Its cost is less than that of even an unsatisfactory substitute.

Unitrol's advantages are so great, its ability to save time, money and space as well as to solve building problems is so extensive that it requires a full-size 36-page booklet to tell them all. This booklet "Unitrol . . . the Next Step Forward in Motor Control" is sent free and without obligation to business executives. Dictate a memo to your secretary now—to send for a copy of this interesting book. CUTLER-HAMMER, Inc., *Pioneer Electrical Manufacturers*, 1310 St. Paul Ave., Milwaukee, Wisconsin.

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Fig. 1434
Pat's. Pend'g.

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Because of the speed-up advantages, "Unbrako" is being specified exclusively by an ever-growing list of companies.

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# Topics

GRAPHITIC steel dies are turning in an enviable record for cold-nosing 105-millimeter shells. With 4,000 impressions regarded as a previous maximum, these dies have turned out 50,000 without signs of appreciable wear.

♦

MUSIC for restaurants, now broadcast locally over telephone connections, is being planned for transmission by frequency modulation over restricted areas. To prevent nonsubscribing establishments from listening in, the entertainment will be broadcast scrambled with a "pig squeal". Only subscribers will have the key to unlock the program of music.

♦

INDICATIVE of the trend toward standardization is the newly announced "standard speed program for gearmotors" of the American Gear Manufacturers Association. Particularly opportune at this time in view of the encouragement given to industry by OPM and OPAC to develop simplification programs in co-operation with the United States Bureau of Standards, the standards are based on a preferred number series. Using a ratio of 1.225, the standard speeds are 1750, 1430, 1170 revolutions per minute and so on.

♦

RUSTPROOF welds for galvanized or other metal parts eliminates entirely the need for dipping a fabricated member for corrosion resistance. Also, this newly developed weld permits finishing operations such as painting or enameling without danger of sweating. The necessity of applying a filler coat before finishing is eliminated. Consisting essentially of rubbing a stick of low melting galvanizing material over the bare spots, the process utilizes the residual heat of welding.

♦

MOLDED fan blades of laminated phenolics for cooling towers are proving to be better as substitutes than the aluminum and magnesium formerly used. Being lighter, they reduce the load on the bearings and because the surface is smooth and corrosion resistant, no finishing operations are required.

MAKING magnesium from sea water in such quantities that the United States and England will soon surpass Germany's production, this strategic material is vital to defense production because of its light weight. Even though concentration is low in sea water, one cubic mile will yield four and one-half million tons.

♦

NEW synthetic rubber has been developed which combines the qualities of natural rubber and the oil resistance of most synthetics. This new neoprene is as "freeze resistant" as rubber, withstanding subzero temperatures, and is especially useful in automobiles and aircraft.

♦

ENVIABLE is the record of the Chicago Tractor plant of the International Harvester plant with respect to crankshaft production. Using induction hardening, over 2,000,000 units have been treated without a single reject. In addition, it was possible to substitute cheaper and readily available carbon-chrome steel for the nickel steel used in a former process as well as to reduce materially the processing time.

♦

FOOLPROOF test for crankshafts and other highly stressed members consists of magnetizing the part, with the direction of flux such that it will intercept any possible cracks at right angles. Then kerosine containing finely divided particles of magnetic iron oxide in suspension is sprayed on. Any cracks or discontinuities in the metal set up magnetic poles strong enough to attract the particles and outline a crack invisible to the naked eye.

♦

ADAPTING plastics to national defense, the Army is pacing the current rapid expansion of the plastics industry. Chief interest is for use as components of ammunition. Extensive experiments are being conducted with plastic false windshields for 37 millimeter armor-piercing shells, bodies of bomb fuses and fins for mortar shells. In addition, considerable quantities of synthetic materials are utilized for truck and telephone parts, instruments, gas masks, liners for helmets, etc. Well-known applications to aircraft include acrylics for windows, noses, hatch covers, tail empennages, landing light covers and rear gunners' turrets.

MACHINE DESIGN

# How Vanadium Influences Design Materials

**C. N. Dawe**
*Mgr. Automotive Div.*
*Vanadium Corp. of America*

VANADIUM as an alloying element in steel has, in recent years, experienced a rapidly increasing number and range of applications. Small percentages have been found to contribute a variety of valuable properties—from toughness, uniformity and carburizing qualities in the smallest forgings and springs to higher impact resistance, reduction of internal defects, and increased strength in the largest forgings and castings. In addition, a number of other effects generally accompanies the presence of a small amount of vanadium. These include improved machinability, simpler heat treatment, reduced distortion, exceptional weldability, increased wear resistance, better control and uniformity of hardness penetration and gradient, smoother finish, and reduced flaking or spalling of carburized surfaces.

Evidence of these and other properties of vanadium is, perhaps, most easily surveyed by an inclusive summary of the principal vanadium steels now in use. For this purpose, four tables are presented herewith, broadly classifying forging steels in heavy sections, forging steels in light sections, spring steels and cast vanadium steels;

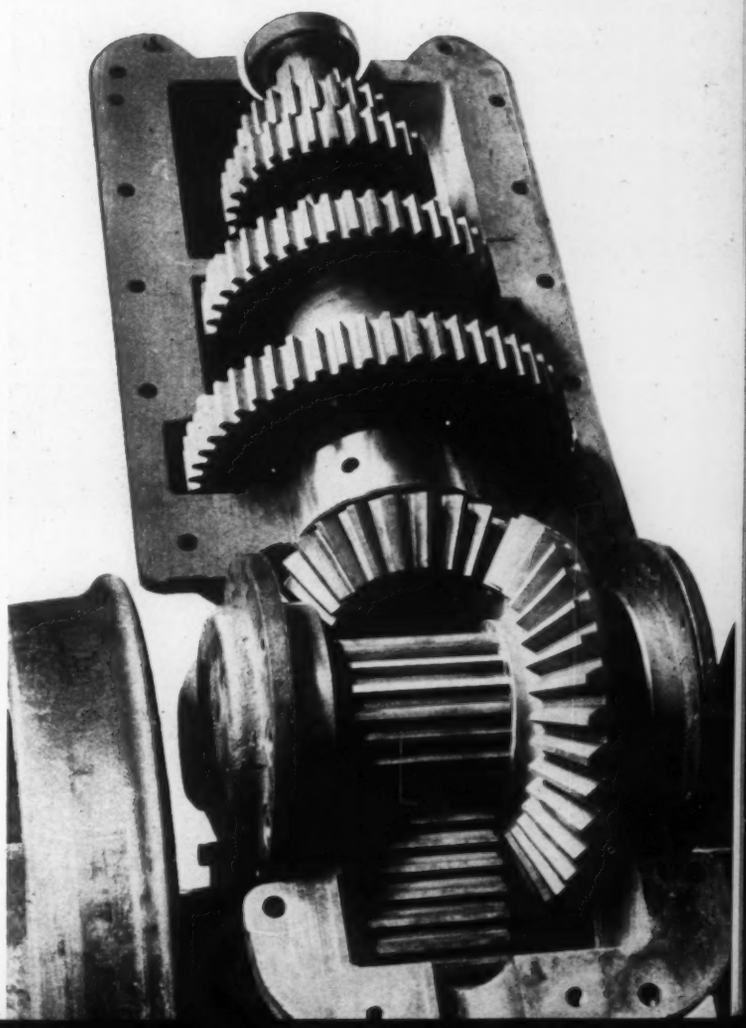


*Fig. 1—Application to locomotive transmissions is typical of the use of chromium vanadium steel gears*

in each case the chemistry, heat treatment, uses and some of the special characteristics of the steels are briefly listed.

Many heavy forgings of high quality are now made of vanadium steel. For example, in turbine shafts, straight and eccentric driving shafts, and for certain parts of heavy ordnance, steel with a vanadium content of .05 to .20 per cent has been virtually standard for many years. Small additions of vanadium increase impact resistance, ductility and toughness—contributions which are reproducible and constant for a given steel and a given heat treatment.

Using a full proportion of silicon and a minimum or no aluminum, vanadium eliminates or greatly

*Fig. 2—Leaf springs of silicon vanadium steel are used on New York Central's "Mercury"*

TABLE I

**Wrought Vanadium Steels in Heavy Sections**

| Analysis | Condition and Treatment | Uses | Remarks |
|---|---|---|---|
| **Carbon Vanadium Steels**<br>C .45-.55<br>Mn .70-.90<br>P .045 Max.<br>S .050 Max.<br>V .15 Min. | Usually normalized large sections and tempered. Sometimes quenched and tempered. Double normalizing develops maximum toughness. | Locomotive and heavy machinery forgings. In railroad equipment: Main and side rods, driving axles, crankpins, piston rods, valve gear, etc. | Excellent fatigue resisting qualities. Unusual wear resistance. Specification minimum requirements in normalized and tempered condition are:<br>**Size of Parts (Diam. or Thickness)**<br>Up to 5 in. / 5-9 in. / 9-13 in.<br>Y.P. (psi.) ..... 60,000 / 60,000 / 58,000<br>T.S. (psi.) ..... 90,000 / 90,000 / 90,000<br>Elong. (% in 2") 24 / 22 / 21<br>R.A. (%) ..... 48 / 44 / 42 |
| Same as above | Flame hardened subsequent to normalizing and tempering. | Forged pinions, teeth flame-hardened; rapid-cooled by stream of quenching liquid. | Resistance to grain growth on heating to temperatures appreciably above transformation insures proper combination of toughness and hardness. |
| **Chromium Vanadium Steels**<br>SAE 6130 to 6150 inclusive | Principally normalized and tempered. Quenched and tempered when required and section and shape are suitable. | Locomotive axles, crankpins, main pins, tires. | Wear and fatigue resistance. |
| A class similar to above but containing .90-1.20 Mn and 1.00-1.25 Cr. | Quenched and tempered. | Gears, driveshafts, eccentric shafts for crushing machinery, etc. | Available in heat-treated bars. Cross section limited to about 12 inches max. and, to meet uniform strength of about 140,000 psi. for all sizes, carbon is varied from .30 to .50 |
| **Manganese Vanadium Steel**<br>C .27-.34<br>Mn 1.45-1.75<br>P .045 Max.<br>S .050 Max.<br>V .15 Min. | Normalized and tempered. Also, quenched and tempered. | Same general classes of use as shown above for carbon vanadium steels. Mn-V steel is especially suited to severe service conditions in cold climates, low temperature processes in oil and general chemical industries, etc. | In large masses this steel combines high strength or hardness with excellent ductility and impact resistance. High wear resistance. Typical properties in normalized and tempered condition are:<br>**Size of Parts (Diam. or Thickness)**<br>5 in. / 9 in. / 13 in.<br>Y.P. (psi.) ..... 80,000 / 81,000 / 74,000<br>T.S. (psi.) ..... 103,000 / 105,000 / 99,000<br>Elong. (% in 2") 26.5 / 26 / 25<br>R.A. (%) ..... 65 / 62 / 58<br>Hardness penetration uniform from surface to center. |
| **Chromium Molybdenum Vanadium Steels**<br>C .35-.45<br>Mn .50-.80<br>Cr 1.25-1.50<br>Mo .30-.40<br>V .15-.20 | Principally quenched and tempered. Also, highly effective when normalized and tempered. | Crankshafts, heavy duty gears. | For moderately large sections requiring full penetration of high hardness with high resistance to sudden loading (high ductility and impact strength). |
| C .37-.44<br>Mn .60-.90<br>Cr .80-1.15<br>Mo .40-.60<br>V .12-.18 | Oil quenched and tempered; or normalized and tempered. | Heavy sections for railroad and general use. With carbon around .60 per cent, for die blocks. | ASTM tentative A17 forging billet specification. Makes excellent die blocks where toughness and wear resistance are of paramount importance. |
| **Nickel Molybdenum Vanadium Steels**<br>C .22-.28 or .27-.33<br>Mn .50-.80<br>Ni 2.25-2.75<br>Mo .15-.35<br>V .15 Min. | Normalized and tempered. | Heavy sections for railroad and general use. | ASTM tentative A17 forging billet specifications. Yield point runs 90,000 psi. with excellent ductility. |
| **Nickel Chromium Molybdenum Vanadium Steel**<br>C .30-.35<br>Mn .60-.80<br>Ni 1.50-2.00<br>Cr .55-.80<br>Mo .40-.50<br>V .10-.20 | Quenched and tempered; normalized and tempered. | Drop hammer piston rods and other similar straight forgings. | Has advantage of low carbon content which is possible in view of high total alloy content. |

TABLE II

## Wrought Vanadium Steels in Light Sections

| Analysis or SAE No. | Condition & Treatment | Uses | Remarks |
|---|---|---|---|
| Carbon Vanadium Steels<br>C .45-.55<br>Mn .70-.90<br>P .045 Max.<br>S .050 Max.<br>V .15 Min. | Normalized, or normalized and tempered, cooled in air or furnace; or quenched and tempered. | Crankshafts and other parts in moderately stressed service. | Superior mechanical qualities, fine machining qualities in the normalized state, low distortion. Crankshafts restruck and die-straightened at normalizing temperature are ready for machining without further heat treatment. |
| I: C .12, Mn .35, V .15<br>II: C .15, Mn 1.00, V .15 | Gas welded. | Welding rod. | Deposits of fine grain structure, uniformity, high yield ratio, exceptional impact resistance. |
| C .15<br>Mn .65<br>V .20 | Welded. | Hammer-welded and fusion-welded plate for boilers and other pressure vessels of light section. | High strength and load-sustaining capacity at elevated temperatures. |
| Chromium Vanadium Steels<br>6115<br>6120 | Case carburized: Carburized and cooled in pots; oil quenched or water quenched and tempered. | Automobile and aircraft engine gears, shafts and piston pins; ball and roller bearing parts. | Hard, tough, strong case of high wear-resisting quality. Case and core strongly bound together. |
| 6115<br>6120<br>6125 | Mostly stress-relieved after welding; some fully annealed. | Welded pressure vessels and welding rods. Aircraft propeller blades welded from plates. | High useful strength due to high elastic limit and yield point. Good welding qualities. |
| 6120<br>6125 | Cyanide hardened. | Gears, bolts, washers, small stampings and forgings. | Extremely fine nitride formation, no coarse acicular structure. Insures case toughness and resistance to spalling. |
| 6120<br>6125 | No heat treatment, or mildly tempered or stress-relieved. | Boiler construction, superheater tubes, tubing for chemical industry, bolts. | Plates and hot-rolled tubing have T.S. 80,000-100,000 psi. at room temperature and twice load sustaining capacity of carbon steel at 900-950 degrees Fahr. |
| 6125<br>6130<br>6135 | Normalized, cooled in air. Quenched into water or brine. Tempered to brinell hardness of 330-270 as required. | Automobile axles, steering arms, levers, etc. Aircraft propeller shafts, hubs, body fittings, etc. In auto and aircraft engines, crankshafts, connecting rods, valve and operating parts. | For parts requiring high strength and toughness and wherever it is necessary to machine after heat treatment. Wears down tools far less rapidly than other steels when hardness corresponds to a tensile strength of 120,000-170,000 psi. |
| 6135<br>6140<br>6145<br>6150<br>6155 | Normalized, cooled in air. Quenched into oil. Tempered to brinell hardness of 500-270 as required. | Small bevel and spur gears, transmission gears, rocker arms, shafts, springs, connecting rods, etc. | High yield ratio with good ductility, toughness and wear resistance; high endurance ratio, hence resistance to fatigue. |
| 6150 | Normalized, cooled in air. Quenched into oil. Tempered to brinell hardness of 580-320 as required. | Gears and other highly stressed parts such as shafting. | Movement or distortion of Cr-V steel gears on quenching is uniformly low. |
| 6145 | Expert welded. No subsequent treatment. | Welding rods for rails. | Deposits have tough wear resistant surface. Brinell hardness 300 as deposited, work hardens to 440. |
| 6195 | Oil quenched and tempered as required. | Tools, ball and roller bearings, wearing plates and other fully hardened parts. | High hardness and resistance to compression; resistance to impact loading; good cutting qualities, excellent wear resistance. |
| Manganese Vanadium Steels<br>C .27-.34<br>Mn 1.45-1.75<br>P .045 Max.<br>S .050 Max.<br>V .15 Min. | Normalized and tempered, or quenched and tempered. | Small forgings, such as locomotive valve mechanisms. | Combination of high yield point, high ductility, high impact resistance. For parts of moderate hardness subject to extreme impact stresses. High ratio of endurance limit to tensile strength. |
| C .13-.18<br>Mn 1.20-1.45<br>P .040 Max.<br>S .050 Max.<br>V .08-.12 | As rolled. Also, welded and possibly stress relieved. | Plates ⅛-4 inches thick and various rolled structural shapes for ships, tanks, transportation and other manufacturing equipment. Also rivets, bolts and auxiliary articles. Welded construction. | High yield strength and impact resistance plus superior welding qualities. Successfully fabricated by both gas and electric welding and by riveting. Mn-V rods used when welds are ground flush. |
| Normalloy<br>C .15-.50<br>Mn 1.00-1.60<br>Cr .30-.65<br>P .040 Max.<br>S .050 Max.<br>V .06-.12 | Normalized. No temper required in most cases. Also, quenched and tempered. | Crankshafts, wheel hubs, eccentrics, and other forged parts of irregular outline and thickness. .15-.20 carbon steels for carburized parts of thin case. .25-.35 carbon range especially suited to moderately stressed parts such as automotive axles, knuckles, arms and shafts. | High yield ratio and impact strength, no distortion in heat treatment, machining and service. Unusual machining qualities. Good carburizing; tough and ductile. |
| Low-carbon Chromium Nickel Vanadium Steel<br>C .12-.17<br>Mn .30-.50<br>Cr .45-.75<br>Ni .40-.60<br>P .040 Max.<br>S .050 Max.<br>V .12-.18 | Carburized. | Automotive gears and similar parts. | For applications where freedom from warpage is required or a fine finish is necessary with moderate core strength. |
| Molybdenum Vanadium Steels<br>I: C .40, Mn .60, Mo .25, P .030 Max., S .040 Max., V .15 Max.<br>II: C .45, Mn .85, Mo .35, P .030 Max., S .040 Max., V .15 Max.<br>III: C .20, Mn 2.00, Mo .30, P ... , S ... , V .20 | | | |
| Types I & II | | Primarily for machined parts. Also, of high value in forged parts. Welded assemblies heat treated to moderately high hardness after welding. | High yield ratio, good machining qualities and impact resistance. Good welding qualities. |
| Type III | | Tubes, plates, etc. at elevated temperatures. | High creep strength. |

TABLE III

## Vanadium Spring Steels

| Analysis | Treatment | Uses | Remarks |
|---|---|---|---|
| SAE 6150: Chromium Vanadium Steel<br>C .45-.55<br>Mn .50-.80<br>Cr .80-1.10<br>P .040 Max.<br>S .040 Max.<br>V .15-.20 | Wire furnished (1) annealed for full heat treatment after forming into springs; (2) hard drawn; or (3) cold drawn and quenched and tempered. In conditions (2) and (3) for certain types of service, steel can be worked and coiled without rupture, requiring only a final stress-relieving heat treatment. | Small and medium size springs. Flats for assembled elliptic springs of many leaves such as auto chassis springs. Helical valve springs for internal combustion engines, steam valves, etc. | Coil springs of this steel are generally made from bars not exceeding ⅝-inch diameter. |
| SAE 6160: Chrome Vanadium Steel<br>C .55-.65<br>(Other elements as above)<br><br>Chromium Vanadium Steel for automotive use:<br>C .45-.55; Mn .70-.90; Cr 1.00-1.20; P .040 Max.; S .040 Max.; V .15-.20<br><br>Chromium Vanadium Steel for railroad use:<br>C .50-.60, Mn .60-.90; Cr .90-1.15; P .045 Max.; S .045 Max.; V .15 Min. | When formed or coiled from hard drawn, or cold drawn and quenched and tempered wire or flats, requires only stress relief. When hot formed, or coiled from cold drawn and annealed wire preferred treatment is: Quenched in oil; tempered to brinell number of 380-460. | Hot formed springs of greater thickness than above including full elliptic, semi-elliptic, disk, ring, etc. Leaf springs for autos and locomotives. Coil springs for heavy machinery such as crushers and presses; also railroad work. | Major purpose of these compositions is to insure in larger sections the same strength properties at a given tempering temperature than can be secured in SAE 6150 in ½-inch diameter.<br>Typical physical properties are:<br>Y.P. psi. ..... 170,000-210,000<br>T.S. psi. ..... 190,000-230,000<br>Elong. (% in 2") 14-10<br>R.A. (%) ..... 45-30<br>Brinell Hardness 380-460<br>Rock. C Hard... 40-48 |
| Silicon Vanadium Steels<br>C .60-1.00<br>Si .50-.75<br>Mn .45-.65<br>P .045 Max.<br>S .045 Max.<br>V .15-.20 | In range .88-.98 carbon for large springs, quenched in oil; tempered to brinell hardness of 380-444. | Lower carbon steels for springs of annealed or cold drawn wire. Higher carbon steels for helical springs from ½-inch or larger diameter bars; especially successful for trucks of railway cars and locomotives. | Carbon content of this type of steel adjusted to the size and nature of particular springs. Marked free-scale properties. Typical physical properties of the higher carbon range, quenched and tempered, ½-1½-inch bar sizes are:<br>Y.P. psi..... 175,000-200,000<br>T.S. psi. ..... 195,000-220,000<br>Elong. (% in 2") 10-8<br>R.A. (%) ..... 30-20<br>Brinell Hardness 380-444<br>Rock. C Hard... 40-46 |

| Other Vanadium Spring Steels | I | II | III |
|---|---|---|---|
| C | .40- .65 | .55- .65 | .50- .60 |
| Si | .20- .35 | 1.80-2.10 | 1.80-2.10 |
| Mn | .20- .35 | .80-1.00 | 1.00-1.25 |
| Mo | ..... | .45- .60 | 1.20-1.40 |
| Cr | 1.00-2.00 | ..... | ..... |
| W | 1.50-2.50 | ..... | ..... |
| V | .20- .40 | .30- .40 | .30- .40 |

Oil quenched and tempered.

Springs for use at elevated temperatures.

For high creep strength at temperatures above those for which chromium vanadium spring steels are suited.

reduces the frequency of defects such as banding, or the internal ruptures that result from slight deviation from optimum heating or cooling rates. By this means, good transverse tests are assured and difficult specifications are readily met without costly reheat-treatment.

Applications of wrought vanadium steels in heavy section have a history of over thirty-five years. Chromium vanadium in the quenched and tempered condition was the earliest of these steels. Later carbon vanadium replaced it as the principal alloy steel for railroad application and still is one of the leading materials in driving axles, main and side rods, crankpins, engine truck and trailer axles, piston rods and other highly stressed parts.

Manganese vanadium, chromium molybdenum vanadium, and manganese molybdenum vanadium steels were developed in later years to meet the demand for greater hardness, wear resistance, increased ductility and impact strength, and exceptionally high elastic limits. The numerous and varied uses of these steels for heavy forgings are

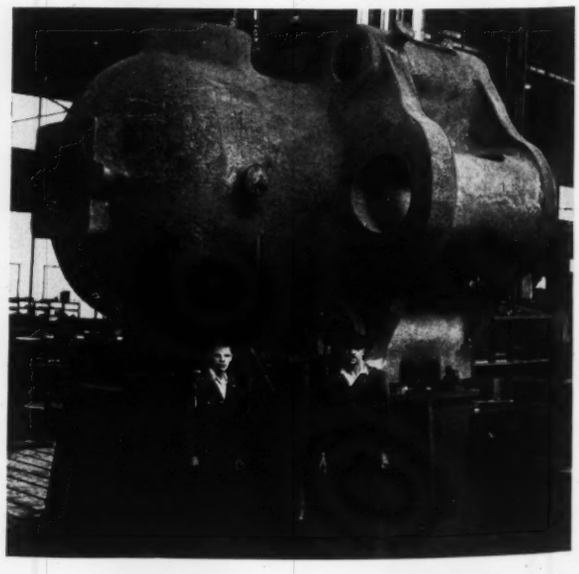


*Fig. 3—Hundred-ton molybdenum vanadium hydraulic cylinder casting for an extrusion press*

detailed in TABLE I. In particular, it may be noted that among these steels are several with long performance records in applications which require unusual fatigue resistance and resistance to impact at low temperatures.

The greatest tonnage of alloy steels is, of course, used in small sections, that is, not over three inches in diameter or thickness. TABLE II outlines the general classifications of vanadium applications in such fields, exclusive of spring and tool steels.

In small sections of carburized vanadium steels, long life of parts of high surface hardness is partially the result of low hardness gradient between case and core combined with high core strength and toughness. In others, less drastic quenching produces high case hardness with a rapid but uniform gradient to a tough and ductile core. Case carburized, cyanide hardened, or nitrided, many vanadium steels, especially some of the SAE 6100 series, have long records in gears, pinions, shafts, bolts and other small forgings.

One of the most satisfactory features of vanadium steels in small sections has been the adaptability to fabricating problems—machining, simple heat treatment after machining, and reduction of distortion. Other beneficial effects of vanadium are particularly evident in certain welding applica-

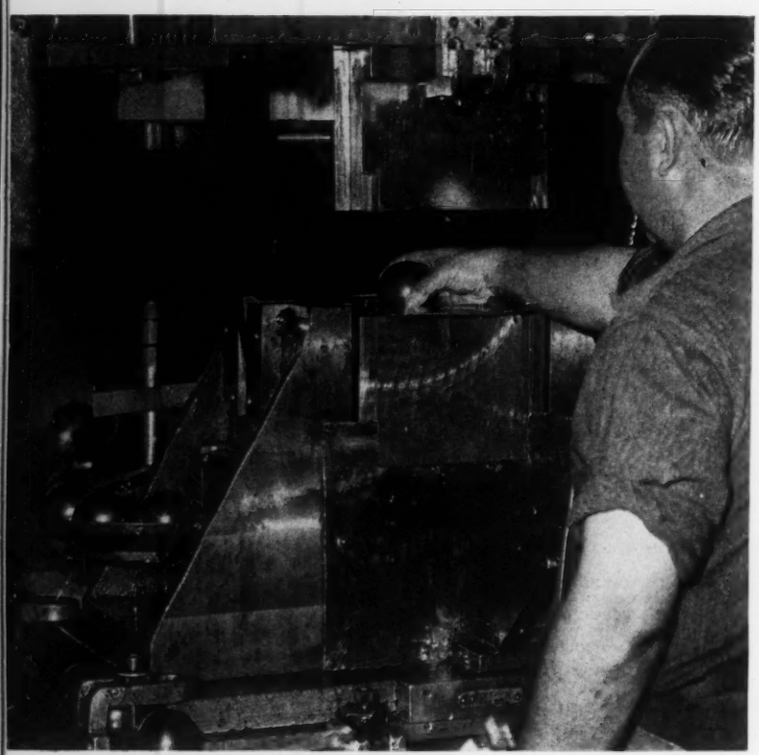
(*Continued on Page* 110)

TABLE IV

**Vanadium in Cast Steels**

| Analysis | Treatment | Uses | Remarks |
|---|---|---|---|
| Carbon Vanadium Steels<br>C .28-.42<br>Si .25-.50<br>Mn .75-1.00<br>V .15-Min. | Usually: Normalized and tempered.<br>Sometimes: Double normalized and tempered. Also, quenched and tempered. | Locomotives and other heavy machinery. All three of the following cast steels — carbon vanadium, nickel vanadium and manganese vanadium—are widely used in the normalized state for:<br>In railroading; crossheads, cylinder heads, truck frames, eccentric cranks. Forging hammer rams, gears, bearing caps, crankshafts and rolls in steel plant machinery. Cylinder side plates and valve bodies in hydraulic presses and pumps. | ASTM tentative specification for minimum physical properties (See A). Representative properties of a .35 carbon grade (See B).<br>A B<br>Y.P. (psi.) ..... 55,000 60,000<br>T.S. (psi.) ..... 85,000 91,000<br>Elong. (% in 2") .. 22 25<br>Reduc. of Area (%) 42 44<br>Good fatigue and wear resistance. |
| Nickel Vanadium Steels<br>C .26-.33<br>Si .25-.50<br>Mn .85-1.10<br>Ni 1.35-1.65<br>V .08-Min. | Usually: Double normalized, generally, but not always, followed by tempering. Also, single normalized and tempered; or double annealed; or quenched and tempered for simpler cast forms. | See uses listed under carbon vanadium cast steels. Also, especially suited to railway equipment in northern climates, low temperature processes in the oil and chemical industries, etc. | For common minimum specifications, (See A); Representative properties of a normalized and tempered steel (See B):<br>A B<br>Y.P. (psi.) ..... 60,000 68,000<br>T.S. (psi.) ..... 90,000 96,000<br>Elong. (% in 2") .. 25 28<br>Reduc. of Area (%) 50 55<br>Izod impact (ft.-lb.) ..... .. 58<br>Increased ductility and resistance to impact loading with some increase in strength and wear resistance as compared to carbon vana- |
| Manganese Vanadium Steel<br>C .26-.33<br>Si .25-.50<br>Mn 1.40-1.70<br>V .08-.12 | Generally, double normalized and tempered; or double normalized and no temper; or single normalized and tempered. Also, quenched and tempered. | See under Carbon Vanadium Steels (first item above). In quenched and tempered condition, used in castings of simple form where resistance to abrasion is of primary importance. | Absence of microsegregation common to pearlitic manganese cast steels. High mechanical properties with excellent resistance to impact and machining qualities. Common minimum specifications (See A); representative properties of double normalized and tempered steel (See B).<br>Y.P. (psi.) / T.S. (psi.) / Elong. (% in 2") / R.A. (%) / Izod Impact (ft.-lb.)<br>(A) 60,000 / 90,000 / 25 / 50 / .....<br>(B) 70,000 / 95,000 / 27 / 59 / 50-70<br>Excellent fatigue resistance. High impact resistance at low temperatures. |
| Other Cast Steels Containing Vanadium<br>Molybdenum Vanadium<br>C Mo V<br>.35-.50 .30 .05-.10 | Normalized; annealed; quenched and tempered. | Centrifugally cast guns. | Proportional limit — 70,000-75,000 psi. Tensile strength 96,000-101,000 psi. |
| Mn-Cu-V<br>C Cu V<br>.15-.30 .80-1.15 .10 | Double normalized and tempered. | | Good impact strength after precipitation hardening. Typical Y.P. 88,000 psi.; T.S. 105,000 psi.; Izod value 42.0 ft.-lb. or Typical Y.P. 70,000 psi.; T.S. 91,000 psi.; Izod value 76 ft. lb. |
| Cr-Mo-V<br>C Cr Mo V<br>.20 2.50 .40 .25 | Quenched and tempered. | For surface hardening by nitrogen. | Y.P. 120,000-138,000 psi.; T.S. 132,-000-153,000 psi.; Elong. in 2 inches —17-15%; R.A. 65-46%; Izod 63-40 ft.-lb. |
| Cr-V; Cr-W-V; Cr-Mo-V | | Steel mill rolls, piercing points for seamless tubes, oil refinery castings. | Effective at normal and moderately elevated temperatures. |

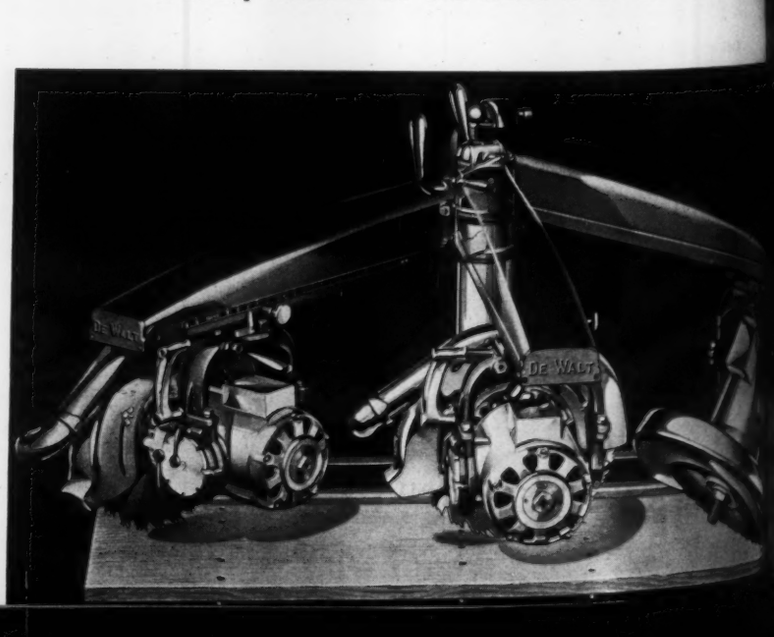
# Scanning the Field FOR IDEAS

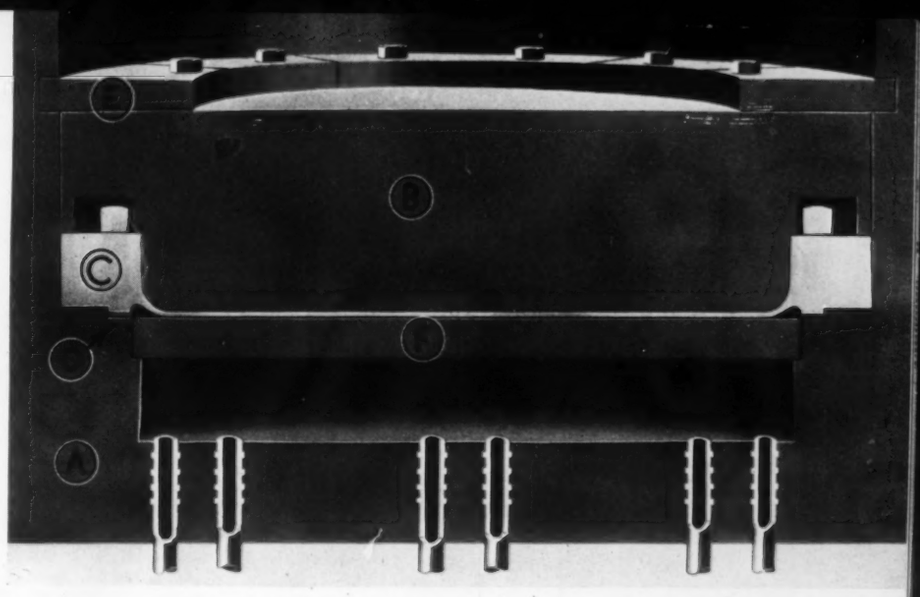


**Ingenuity in design** is reflected in a new method for fabricating steel flanges for Buick torque tube ends as shown at left. These flanges, on each end of the tube, are drilled and bolted to universal joints at the transmission and universal ends. Formerly employing upsetters, the new system utilizes balls and has shown appreciable improvement over the previous method. Essentially, disks are blanked from heavy-gage low-carbon steel strip, with a small hole in the center. This hole is broached out slightly and the disk is then forced over a steel ball, extruding the required collar on the flange for subsequent welding to the torque tube proper.

One of the problems incident to development of this method was that of obtaining satisfactory steel balls. Difficulty was experienced with the flange galling during the process with the result that the steel balls would pick up metal on the surface and become rough and off-size. Chromium steel balls, ground and polished to a high luster, were tried first. Then the surface of the balls was bonderized, showing an improvement. A later change to high-speed steel gave better service. Another problem involved suitable lubricant. Many were tried but finally ordinary machine oil was found to be the best.

**Radial arm** provides versatility for the De Walt circular saw, right. Moving vertically to obtain the desired depth of cut and swinging horizontally, the cantilever arm makes possible any straight or angular cut. For straight-line cutting, the motor yoke moves along the arm. Saw tilts in the yoke, as shown in the phantom view, to any angle. Combinations of various positions provide for unusual and special operations.

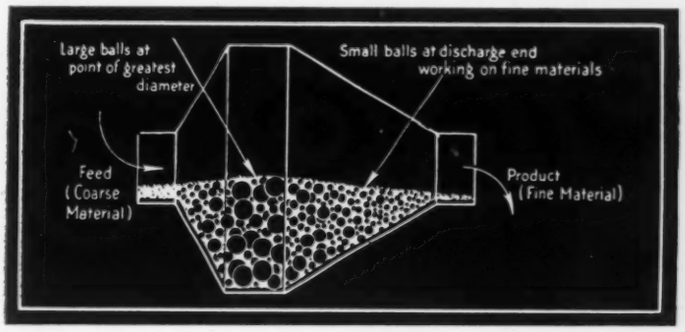


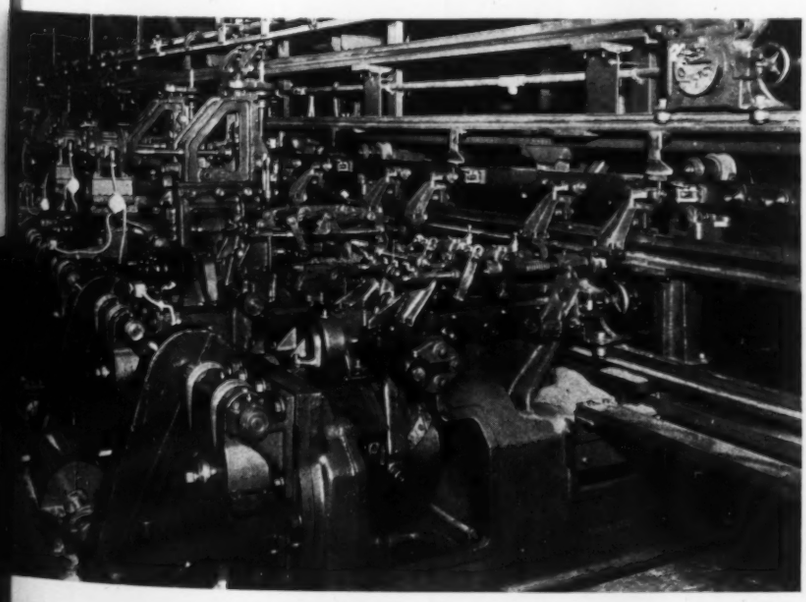


**Pressure vessel closures,** when of large cross-sectional areas subjected to high pressures, would require large flanges to take care of the unusually big bolts necessary. To eliminate these and facilitate maintenance, the Foster Wheeler Corp. developed the design illustrated in the drawing at right which utilizes a diaphragm seal. In this way, with a diaphragm backed by a block to take the load, the bolts in the seal are required only to maintain tightness at the seal, carrying no other load.

Diaphragm member which is shown at (C) is sufficiently flexible to transmit all of the pressure load to the block (B). This block is held in place by a series of segments, (E), which have shear loading against the annular groove in the box forging (A). Flexibility of the diaphragm permits wide tolerances in the fitting of the various members, yet allows transmission of all load to the shear pieces. To prevent rupture of the diaphragm due to a negative pressure, plate (F) restricts the opposite movement and carries any loads imposed by a vacuum.

**Centrifugal action** is utilized in the ball mill, right, to provide continuous operation. Designed by Hardinge Co., progressive grinding or pulverizing to a desired fineness is obtained, discharging automatically the ground materials by overflowing. Steel balls of varying diameters are utilized for this action. The larger or heavier balls displace the smaller ones by their greater outward force. The smaller balls therefore are required to travel around the narrower sections of the cone. Using this principle, the feed is at the large end and the discharge at the narrow end of the mill, making progressive operation automatic.


Large balls at point of greatest diameter
Small balls at discharge end working on fine materials
Feed (Coarse Material)
Product (Fine Material)



**Automatic production** utilizing eleven in-line machining stations, is effected on the machine shown at left for performing 77 operations on G.E. cast-iron meter parts. All machining is performed with the part held in one position in a locating jig, making for accuracy and uniformity of parts.

Transfer mechanism has two levels and moves a series of rail-mounted jigs into position at each station. Drive of cutting tools is mechanical, but transfers are hydraulic because they are intermittent and at comparatively high speed. Synchronized movement is obtained by a master control station, employing limit switches and solenoid valves. Machined part returns on roller chain conveyor and is removed from jig by the operator, who also takes care of loading.

# When To Utilize Porcelain Enamel

By Emerson P. Poste

## Part I—Fundamental Properties

*Fig. 1 — Counter scale utilizes porcelain enameled exteriors to provide easily cleaned surfaces and high appearance factor*

PORCELAIN enamel should not be confused with organic enamels or similar finishes. The physical and chemical characteristics of these two types of materials are so different that, while their fields of application may overlap, as a whole they are applicable to different types of service. Correct use of either finish depends on its fundamental properties and the right design of the base to which it is to be applied.

One of the primary requirements in utilizing porcelain enamel is that the coefficient of thermal expansion of the enamel be correct in relation to that of the base metal. Experience indicates that the coefficient of enamel for sheet iron should be slightly greater than that of the base metal, while the coefficient of cast iron enamel should be close to that of the casting. Second in importance is adherence which depends on chemical factors of the base metal, on the enamel and on conditions of processing. If in a given case, porcelain enamel is the proper coating and correct principles of design are applied, satisfactory adherence will result. Failures in this regard may well result from defects in design.

Deflection through which an enameled member can go without failure depends on many factors including both adherence and elasticity of the enamel coating. An enameled sheet, properly processed, may be deflected through a considerable curvature without failure, but not to a sharp angle. Any strain that will permanently deform the metal will cause failure of the enamel. The enameled surface will resist a surprisingly severe direct blow if the metal is not materially deflected. In general, all parts to be enameled should be so designed and processed that, in assembling or in use, they will not be subject to appreciable strain by deflection or impact.

Tests for determining the resistance of sheet iron enamels to various types of mechanical strain have been developed. Standard tests for sheet iron enamel have been in use for some time and include

*UNAVAILABILITY of strategic materials and improvements in porcelain enamel for especially severe applications has caused many manufacturers to turn to this material for coatings to replace stainless, monel, chromium plating and other resistant surfaces.*

*With an engineering approach, the author discusses the properties and applications of porcelain enamel in a series of articles of which this is the first. Succeeding articles will cover enameled sheet steel and enameled cast iron, respectively*

bending[1], resistance to impact[2], and resistance to torsion[3]. A newer test, indicating quality of adherence, is a "stretch test"[4] in which an enameled sheet iron specimen is deformed lengthwise.

A characteristic that contributes materially to the permanence of porcelain enamel is its resistance to abrasion for which a test has also been developed. Results are expressed as the "abrasion index."[5]

This index is computed by dividing the specular gloss reading after subjecting the surface to action of an abrasive medium by the initial gloss reading and multiplying by 100. The abrasive action used in the test is carefully controlled and consists of placing feldspar and steel balls on the surface and oscillating in a standard machine.

For uses specifically requiring resistance to abrasion, the enamel should have an index of not less than 60. Certain special enamels have shown values over 80, while softer ones, not designed to resist abrasion, may have indexes below 50. All of these values are high compared with nonsilicate surfaces.

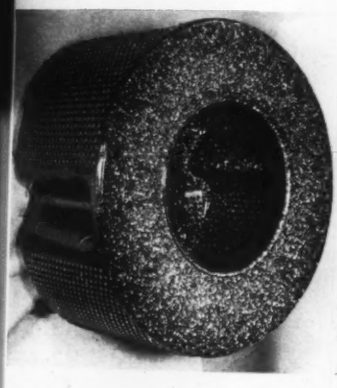
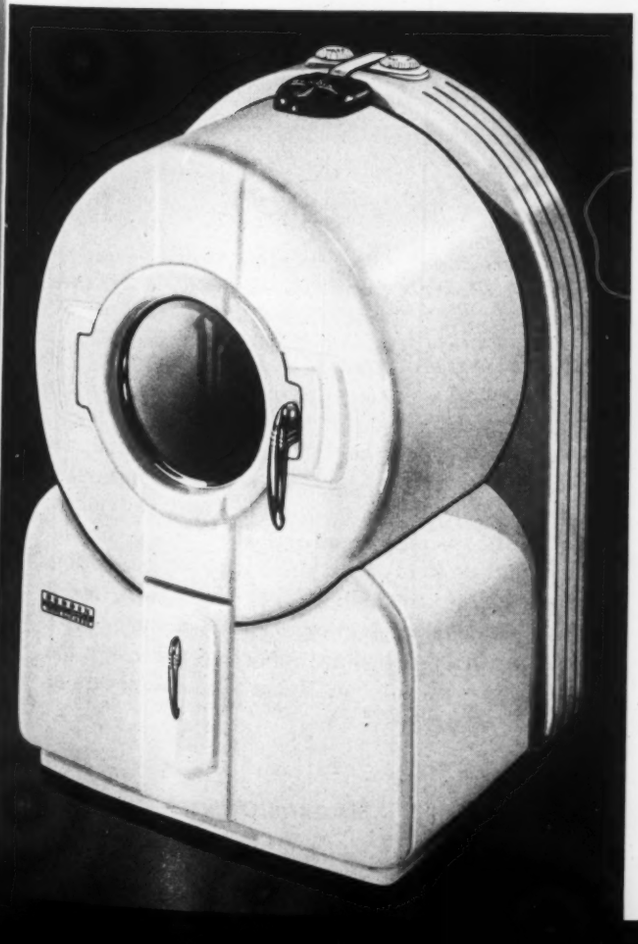


*Fig. 2—Below—Domestic washer is enameled to increase serviceability. Spinner, shown at left, is fabricated steel enameled for resistance to abrasion and akaline solutions*



Though fused to metal at high temperatures during processing, the limiting temperature of enamel in use is well below its initial softening point. Thermal conditions alone would not affect commercial enamels at temperatures up to approximately 900 degrees Fahr. Adverse mechanical conditions, however, may accompany high temperatures so as to lower the safe limit. Abnormal local strains may arise from unequal temperature conditions, uneven or too rapid rates of heating or cooling. Hence, no set maximum safe temperature can be determined. The fact that enamels of the correct type are in satisfactory use on gas engine exhaust manifolds indicates resistance to high temperature.

## Acid Resistance Defines Three Classes

Porcelain enamel should not be exposed to alkalies in general, though it is reasonably resistant to all but those containing free caustic. As to acid resistance, enamels fall into three general classes. In the first are compositions designed to resist normal atmospheric conditions and solutions that are essentially free from acids. The second involves enamels that are resistant to organic acids such as acetic and citric. The third includes those that are resistant to mineral acids in general, with the exception of hydrofluoric acid.

Terminology as to degrees of acid resistance is not entirely clear. The expressions "stainless" and "acid resistant" are frequently used to designate the second of the foregoing three groups. Tests for the acid resistance of flatware coated with enamel use a solution of citric acid, 100 grams per liter, at atmospheric temperature, and grades the specimens as *AA*, *A*, *B*, *C*, and *D*[6].

As shown in *Fig.* 3, the classes are indicated with respect to etching and pencil-line tests. That is, Class *AA* shows no visible etch and pencil line is easily rubbed off dry. If pencil line is removed only by wet-rubbing test, sample is Class *A*. Passing blurring highlight test but failing wet-rubbing test classifies the specimen as *B*. Failing blurring test but passing disappearing highlight test puts surface in Class *C*. Failure of all tests is Class *D*.

If the term "acid resisting" is used, the enamel must rate not less than grade A by this test. Enamels of the third type are frequently tested by refluxing with hydrochloric acid.

There are conditions under which porcelain enamel should not be used, and they should be avoided carefully. It is at its best when the designer has correctly taken into account the choice of

[1] *Bulletin*, American Ceramic Society, 6 (9) 227 (1927), 7 (12) 360 (1928), 8 (9), 279 and 287 (1929).

[2] "Impact Test for Laboratory Specimens of Porcelain Enameled Sheet Iron and Steel," Porcelain Enamel Institute—August, 1940.

[3] "Torsion Test for Laboratory Specimens of Porcelain Enameled Sheet Iron and Steel," Porcelain Enamel Institute—September, 1940.

[4] *Ceramic Industry*, January 1941, page 78.

[5] "Test for Resistance of Porcelain Enamels to Surface Abrasion," Porcelain Enamel Institute—October, 1938.

[6] "Test for Acid Resistance of Porcelain Enamels—Part I—Flatware," Porcelain Enamel Institute—April, 1940.

enamel and details of design, making such use of color and form as the conditions may indicate.

Use of enameled parts in machines is growing and will be discussed in this and following articles. The success with which this type of finish has been developed in certain fields involving machine design points to its expanding opportunities.

Functions of enameled parts in machines may be divided into two classes. In the first, a mechanism is protected by an enameled housing which may also serve as a portion of the structure supporting moving parts. This is well illustrated by the use of enamel in scales, *Fig.* 1, and similar units. Enamel is also used as a protective coating on the working

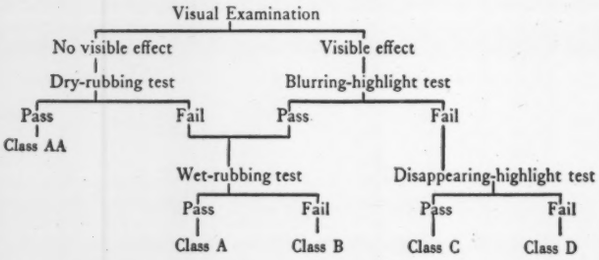



*Fig. 3—Flow chart showing classification of enamels for acid resistance*

parts of various mechanical devices. The most common illustration is the washing machine tub and more recently an enamel-coated clothes spinner, *Fig.* 2. Applications include lining of pump housings and coating of pump impellers, *Fig.* 4, both for the handling of strong acids.

To be right as to gloss, color, integrity of coating, and durability, a reasonably uniform coat of the proper enamel must come to maturity over the entire piece at the correct time and temperature. The heating and cooling cycle, essential to the burning operation, must not produce abnormal local strains either during, or subsequent to, firing. These theoretical requirements have been given considerable latitude through improvements in enameling stock, enamels and furnaces, but should always be kept in mind as ideals to approach.

Applying these concepts to the design of parts to be enameled, the first requirement is that the piece shall be so designed that all surfaces to be enameled shall be accessible for proper finishing, cleaning, and enamel application. The method of application to be used, and its limitations, must be taken into account, as well as other details of the operation as a whole.

Sheet iron should be of proper quality as to enameling characteristics and methods of fabrication such as drawing, spinning, and welding. Cast iron should be made from good raw materials so proportioned as to give the correct composition of iron, and the foundry practice should provide castings that sandblast to a sound, even surface. For either base metal, design and fabrication should avoid as far as possible differences of thickness of metal, the presence of parts that will cause uneven heating due to shading, and other features that would interfere with equal temperature development during firing. These several considerations will be covered more specifically in a later article under the proper headings.

Due consideration should be given to the choice of enamel for a given purpose. If a housing for a mechanical device is involved, practically any desired color may be used and enamels of high acid resistance may not be required. At the other extreme, enamel may serve as a protection against acid action and abrasion. Color then is of no particular importance. There is an optimum choice of an enamel for a given use, and best results depend on that choice.

From the application of the ground coat to the last firing of the finish coat, the part must be supported at points at which a perfect coat of enamel is not essential. In certain cases the manner in which the piece is supported in the furnace during firing has an important bearing on warpage or enamel defects due to mechanical strains. The designer needs to recognize and meet these requirements if processing complications are to be a minimum.

In the design of parts that involve assembly after enameling, due tolerances must be allowed for the warpage that is a characteristic of the firing of enamel. The forcing of matching holes with

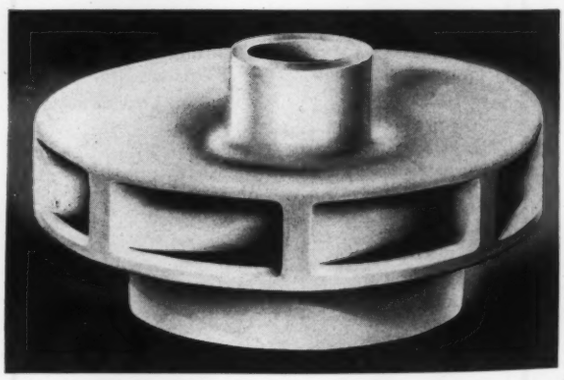


*Fig. 4—Cast pump impeller is enameled to resist the attack of acids. Interior of pump housing is similarly coated*

drift pins or the bending of flanges to force a fit is liable to cause cracking or jumping of the enamel during assembly or later in service.

The human element of interdepartmental cooperation is particularly involved in porcelain enameling. The designer should not only be familiar with the enameling operation as a whole, but he should consult freely with those who are responsible for fabricating, enameling, and assembling. Many applications of porcelain enamel which should have been completely successful have failed because the new design was not considered from all points of view.

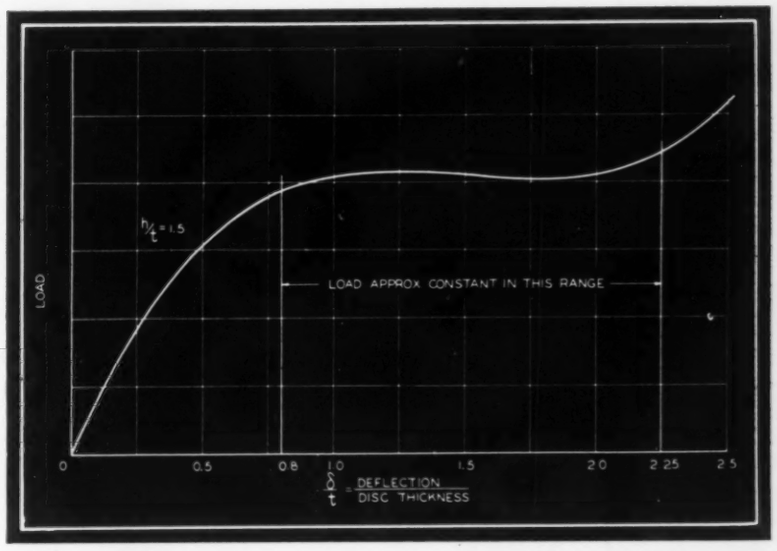



*Fig. 1—Load deflection characteristic of constant-load disk spring*

# Designing Constant-Load Disk Springs

**By A. M. Wahl**

*Westinghouse Electric & Mfg. Co.*

IN APPLICATIONS where a practically constant load is desired over a considerable range of deflection as, for example, in gasket applications, initially-coned disk (or Belleville) springs may be useful. Such springs having a cone height $h$ equal to 1.5 times the thickness $t$ have the flat-topped load-deflection characteristics indicated in *Fig.* 1. For these springs the load is constant within 5 per cent over a range of deflection from about .8 to 2¼ times the thickness.

To design such springs, usually known as "constant-load" springs, the methods and equations developed in the writer's previous article‡ may be used. Calculations, however, may be facilitated greatly by the use of the following discussion.*

From Equation 9 in the previous article, the thickness of the constant-load spring is given by

$$t = \frac{D}{2}\sqrt{\frac{S}{K_1 E}} \quad \ldots\ldots (1)$$

where $D$ = outside diameter of the spring, $S$ = maximum stress in the spring at a deflection of 2¼ $t$, $E$ = modulus of elasticity of the material, and $K_1$ = a factor depending on the ratio $D/d$ between outer and inner diameter of the spring and which may be calculated from Equation 10 of the previous article. Values of $K_1$ for various ratios of $D/d$ are given in TABLE I. Equation 1 may be written as

$$t = \frac{D}{K} \quad \ldots\ldots (2)$$

where

$$K = 2\sqrt{\frac{K_1 E}{S}}$$

Values of $K$ are plotted in *Fig.* 2 as functions of the maximum stress $S$ for various values of $D/d$.

From Equation 7 of the writer's previous paper, the load $P$ is given by

$$P = 4C_1C_2\frac{Et^4}{D^2} \quad \ldots\ldots (3)$$

TABLE I

**Effect of $D/d$ Ratio on Spring Factors**

| $D/d$ | $C_1$ | $C_2$ | $K_1$ |
|---|---|---|---|
| 1.25 | 1.68 | 2.95 | 10.7 |
| 1.5 | 1.68 | 1.9 | 7.6 |
| 2-2.5 | 1.68 | 1.44 | 6.8 |

For a constant-load spring where $h/t = 1.5$ the value of $C_1$ will be 1.68 (this gives the peak value

‡ "Design and Selection of Disk Springs", MACHINE DESIGN, March, 1939.

*Suggested by Mr. R. C. Bergvall of the Westinghouse Electric & Mfg. Co.

of the load, the average value being slightly less). Values of $C_2$ are given by *Fig.* 7 of the previous article and will vary with $D/d$ as indicated in TABLE I.

Substituting the value of $t$ given by Equation 2, in Equation 3,

$$P = \frac{4C_1C_2ED^2}{K^4} \quad \ldots\ldots (4)$$

This may be written

$$P = CD^2 \quad \ldots\ldots (5)$$

where

$$C = \frac{4C_1C_2E}{K^4} \quad \ldots\ldots (6)$$

Values of $C$ are plotted in *Fig.* 3 as functions of the maximum stress $S$ at a deflection $\delta = 2.25t$ for various ratios of $D/d$. This figure is based on $E = 30 \times 10^6$ pounds per square inch which applies to steel springs.

Equations 2 and 5 used in conjunction with *Figs.* 2 and 3 give a simple method of calculating the constant load $P$ for any given spring diameter. In all cases the maximum deflection will be equal to $2.25t$ while the load will be approximately constant at deflections between $.8t$ and $2.25t$.

Design proportions for this type of spring are given in TABLE II for maximum stresses of 200,000, 150,000 and 100,000 pounds per square inch. For springs less than about ¼-inch thick and under static loading, working stress values of 200,000 pounds per square inch and even higher have been found permissible for spring steel†. For heavier springs for fatigue loading, lower stresses than this may be advisable in the absence of actual test data.

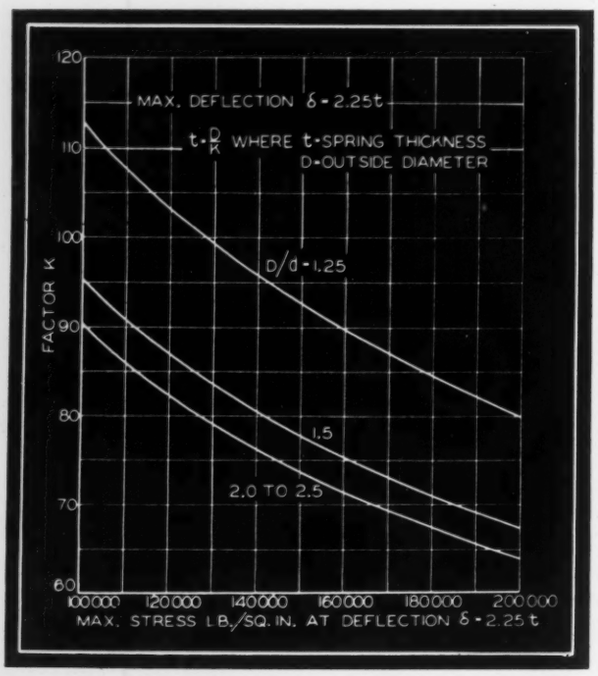



*Fig. 2—Curves for determining thickness for constant-load Belleville springs ($h = 1.5t$)*

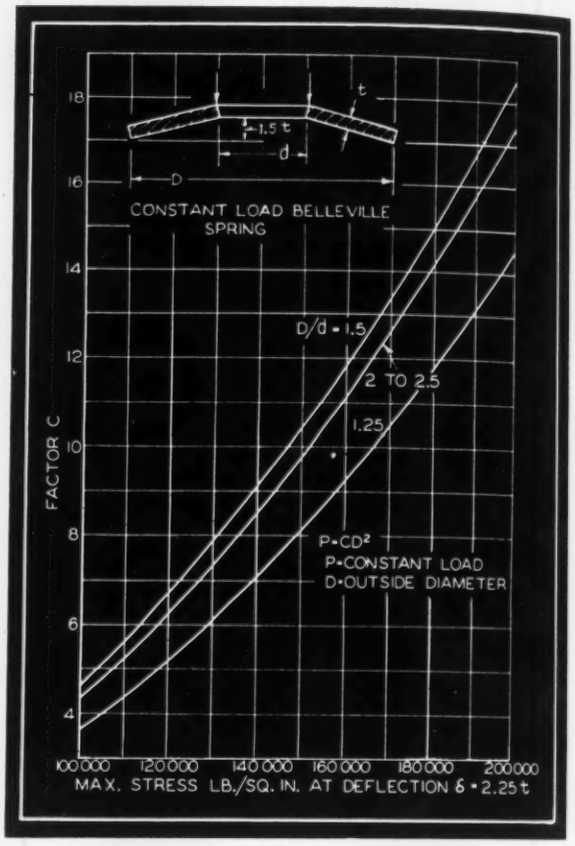



*Fig. 3—Curves for calculating constant-load Belleville springs. These curves apply only if the thickness t is chosen in accordance with Fig. 2*

EXAMPLE: As an example of the application of these formulas, let us assume that a maximum deflection of .2-inch and a constant load of 2000 pounds are needed for a gasket application. Steel springs are to be used with $D = 6$ inches, $d = 4$ inches and $D/d = 1.5$. Since the load is practically static in this case, a working stress of 200,000 pounds per square inch will be used. From TABLE II, for $S = 200{,}000$ and $D/d = 1.5$, the maximum deflection $\delta = D/29.9 = 6/29.9 = .2$-inch. The load $P = 18.5\ D^2 = 18.5(36) = 665$ pounds. To obtain these values requires a thickness of $t = D/67.4 = .089$-inch. Three springs would thus have to be stacked in parallel to give the required load of 2000 pounds.

TABLE II

**Proportions of Constant-Load Steel Springs***

| Maximum Stress $S$ (psi) | Spring Index $D/d$ | Spring Thickness $t$ | Maximum Deflection $\delta = 2.25\,t$ | Constant Load $P$ |
|---|---|---|---|---|
| 200,000 | 1.25 | $D/80$ | $D/35.5$ | $14.5\,D^3$ |
| | 1.5 | $D/67.4$ | $D/29.9$ | $18.5\,D^3$ |
| | 2.0-2.5 | $D/63.8$ | $D/28.3$ | $17.4\,D^3$ |
| 150,000 | 1.25 | $D/92.5$ | $D/41$ | $8.15\,D^3$ |
| | 1.5 | $D/77.8$ | $D/34.6$ | $10.4\,D^3$ |
| | 2.0-2.5 | $D/73.7$ | $D/32.7$ | $9.8\,D^3$ |
| 100,000 | 1.25 | $D/113$ | $D/50.2$ | $3.62\,D^3$ |
| | 1.5 | $D/95.4$ | $D/42.3$ | $4.62\,D^3$ |
| | 2.0-2.5 | $D/90.2$ | $D/40$ | $4.35\,D^3$ |

* Modulus of elasticity $E$ is taken as $30 \times 10^6$ pounds per square inch.

† See article by Almen and Laszlo, Trans. A.S.M.E., May, 1936, p. 305.

# Applying Theory of Elasticity in Practical Design

## Part IX—Contact Loading

By R. E. Orton
*Chief Engineer*
*Acme Steel Co., Chicago*

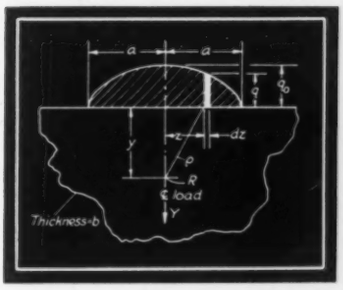



*Fig. 87—Stress in a semi-infinite plate, along load centerline, elliptically distributed load*

LOADING of two parallel rollers and elliptical distribution of pressure across the area of contact, discussed in the preceding article, is illustrated in *Fig.* 87. The pressure intensity is measured by the ordinates to the ellipse constructed with the width of contact area, $2a$, as the major axis, and the maximum pressure $q_0$ as the semiminor. It remains to determine $q_0$, and the local stresses below the surface produced by this load distribution.

It is only in recent years that subsurface stress has come in for its proper recognition as the criterion of failure in contact loading. The original Hertz equations determined only $q_0$. Buckingham, in his treatise on spur gears referred to in the previous article, used only $q_0$ in his design. Thomas and Hoersch[1] in 1930, investigated the subsurface stress and checked its influence on the failure of a plane surface supporting a roller, and on two rollers with crossed axes. This work credits T. M. Jasper with suggesting, some years previously, that the subsurface shear stress "might be a critical factor." Timoshenko, in "Theory of Elasticity," (1934) gives curves showing this stress and makes brief mention of its importance, but does not develop the equations nor present complete data.

To the writer's knowledge, the first general practical application of the shear stress in contact loading as the failure criterion was made by Schmitter[2] in the design analysis of single and double-faced helical gears. This excellent paper has done much to place the design of these important machine elements on a scientific basis. In particular, its application to large reducing gears, such as the primary drives of rolling mills, etc., has been a noteworthy contribution.

Reference was made in the July article in this series to the discussion and photos of actual contact stress failures under fatigue, by S. Way[3]. The pitting effect, due to subsurface failure, is well shown in these pictures.

To determine the subsurface stress it is necessary to return again to the semi-infinite plate and assume that the local stresses in the roller will approximate closely those in the plate. To simplify the mathematics, only the maximum stresses, which are along the load center line, will be found.

Illustrated in *Fig.* 87 is the loading of a semi-infinite plate. The $Y$ axis is taken toward the interior to agree with the convention adopted for rollers in the previous article. Equation[4] 109 gives $S_x$ at any point $R$, within the plate. Making the changes for axes location, direction, and the vari-

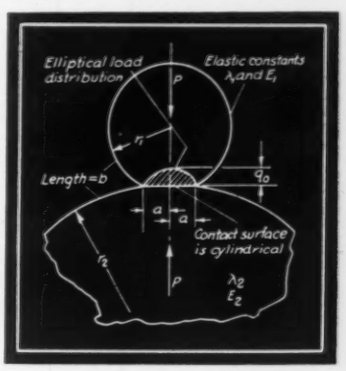



*Fig. 88—Contact loading of rollers. Complete application information is condensed, appearing with reference to diagram*

[1] "Stresses Due to the Pressure of One Elastic Solid upon Another," University of Illinois Eng. Exp. Sta. *Bulletin* No. 212—1930.
[2] "The Design of Helical Gears," by W. P. Schmitter, MACHINE DESIGN, June and July, 1934.
[3] "How to Reduce Surface Fatigue," by S. Way, MACHINE DESIGN, March, 1939.
[4] MACHINE DESIGN, July, 1941, also Sept. 1941.

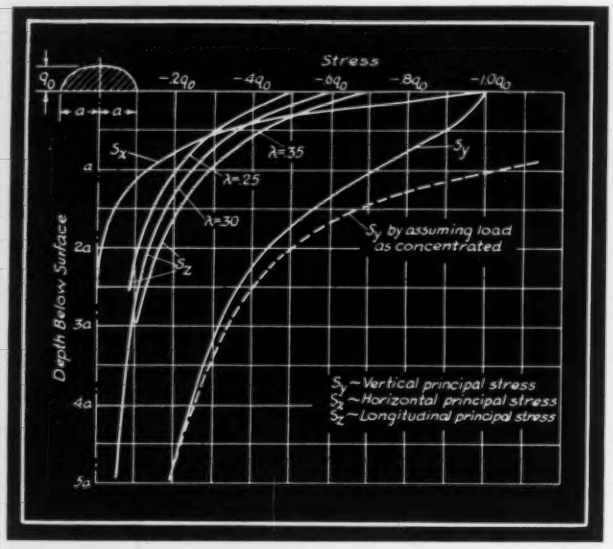



*Fig. 89—Principal stresses along load centerline*

able $z$ gives the substitution of $-z$ for $x$, $-y$ for $y$, and $qbdz$ for $P$,

$$\Delta S_x = -\frac{2yqz^2dz}{\pi\rho^4}$$

from which is obtained, by summing across the load and replacing $\rho$ with $(y^2+z^2)^{1/2}$,

$$S_x = -\frac{2y}{\pi}\int_{-a}^{a}\frac{z^2qdz}{(y^2+z^2)^2}$$

An expression for $q$ is given in Equation 142 of the previous article

$$q = \frac{q_0}{a}\sqrt{a^2-z^2} \quad \text{.....(142)}$$

Substituting, and noting that the integrand is an even function (symmetrical about the $Y$ axis), and that therefore the integral from $-a$ to $a$ is equal to twice the integral from 0 to $a$, gives for $S_x$

$$S_x = -\frac{4q_0y}{\pi a}\int_0^a\frac{z^2\sqrt{a^2-z^2}\,dz}{(y^2+z^2)^2} \quad \text{.....(151)}$$

in which $y$, in the integration, is a constant.

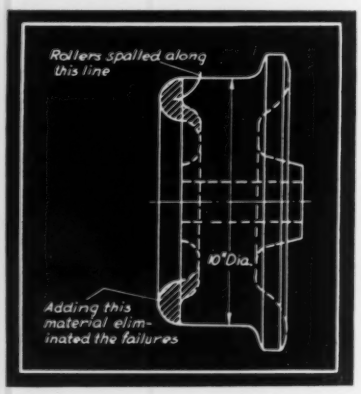



*Fig. 90—Failure of roller by spalling of unsupported ends is indicated by line. Added material is shown in section*

Similarly, $S_y$ is developed from Equation 110

$$S_y = -\frac{4q_0y^2}{\pi a}\int_0^a\frac{\sqrt{a^2-z^2}\,dz}{(y^2+z^2)^2} \quad \text{.....(152)}$$

and likewise for $v_{xy}$ from Equation 111, except that the change in limits may not be made

$$v_{xy} = -\frac{2q_0y^2}{\pi a}\int_{-a}^{a}\frac{z\sqrt{a^2-z^2}\,dz}{(y^2+z^2)^2}$$

The integrand in this last is an odd function, symmetrical about the origin, and therefore the negative half will "balance" the positive, the result of the summation being zero, from which

$$v_{xy} = 0 \quad \text{.....(153)}$$

The integration in Equations 151 and 152 is more readily performed in trigonometric form. Introducing the new variable $\theta$, such that the following expression is obtained

$$z = a\sin\frac{\theta}{2}$$

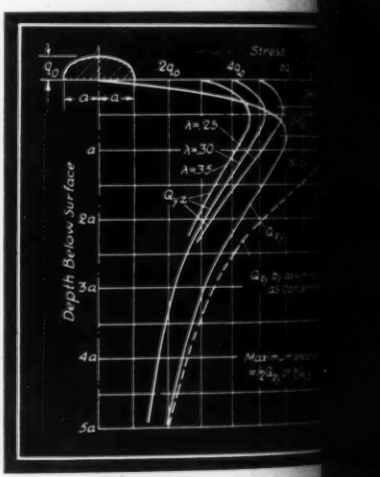



*Fig. 91—Q stress along load centerline*

Equations 151 and 152 reduce to

$$S_x = -\frac{2q_0y^2}{\pi a}\int_0^\pi\frac{(1-\cos^2\theta)\,d\theta}{(k-\cos\theta)^2} \quad \text{.....(154)}$$

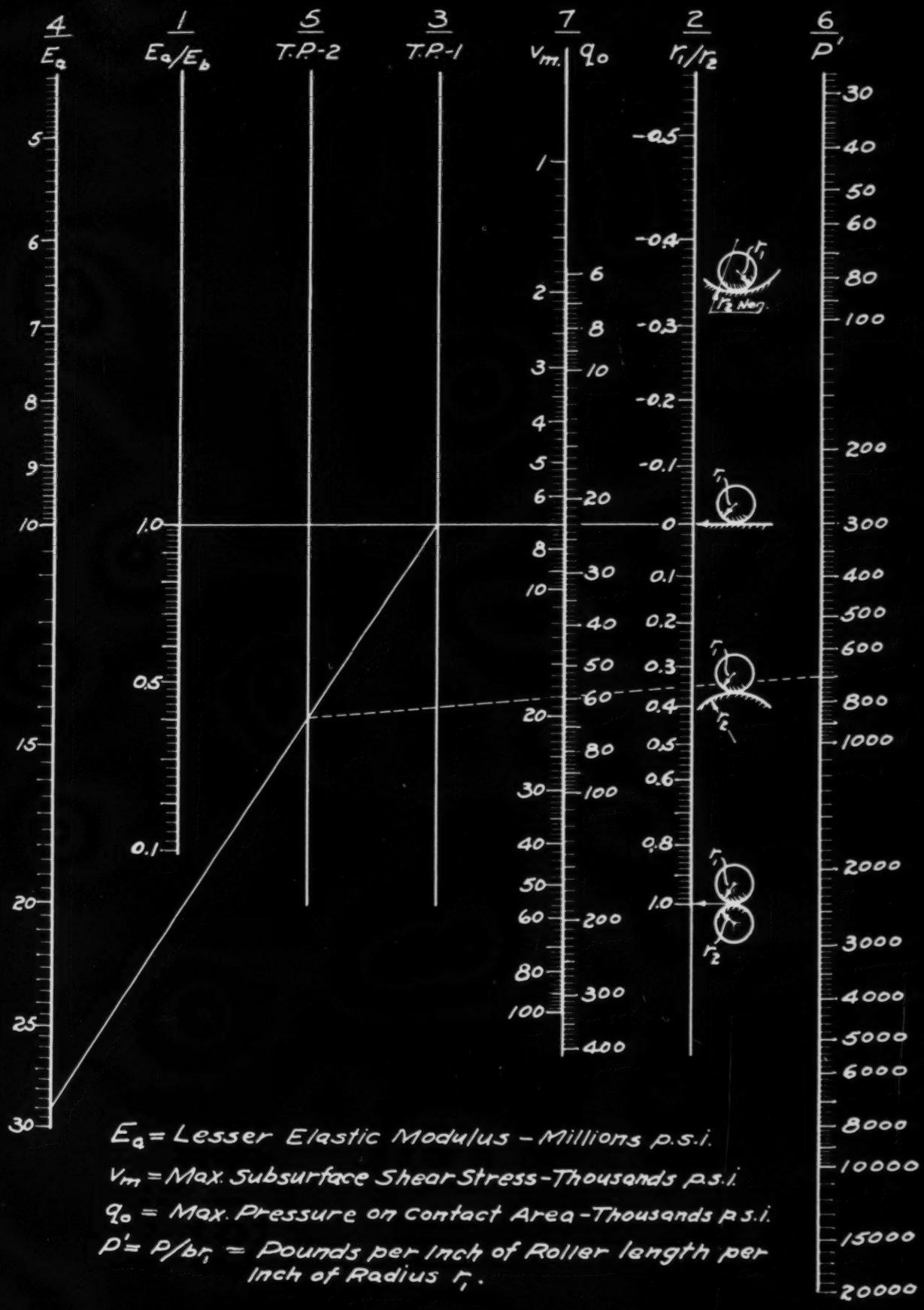
$$S_y = -\frac{4q_0y^2}{\pi a^3}\int_0^\pi\frac{(1+\cos\theta)\,d\theta}{(k-\cos\theta)^2} \quad \text{.....(155)}$$

where $k$ is given by

$$k = \frac{2y^2+a^2}{a^2}$$

and varies $1 \leqslant k \leqslant \infty$. Equation 154 may be reduced to the form of 155 by increasing the integrand by

*Fig. 92—Right—Design chart for contact stress in rollers. Interpretation follows order of column numbers*




$E_a$ = Lesser Elastic Modulus – Millions p.s.i.

$V_m$ = Max. Subsurface Shear Stress – Thousands p.s.i.

$q_o$ = Max. Pressure on Contact Area – Thousands p.s.i.

$P' = P/br_1$ = Pounds per inch of Roller length per inch of Radius $r_1$.

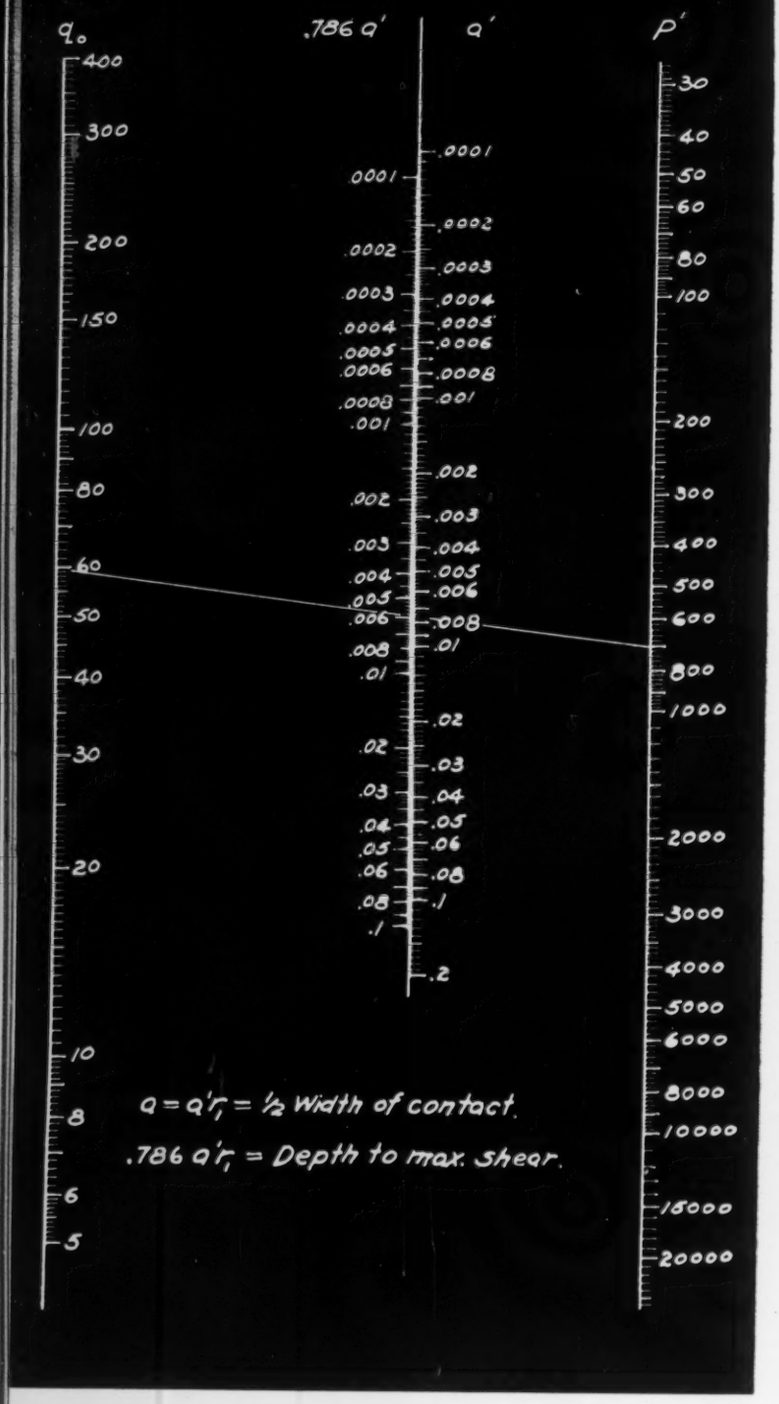



*Fig. 93—Left— Width of contact area as shown in Fig. 88*

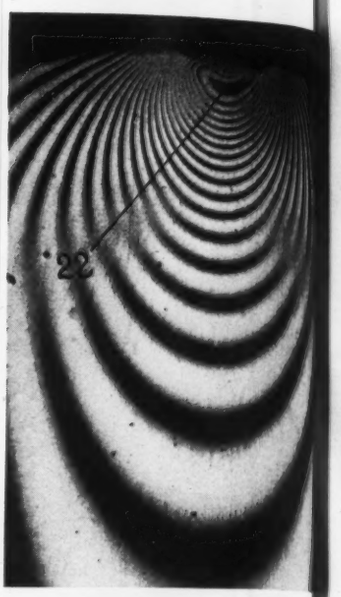


*Fig. 94—Right—Photoelastic picture of disk on steel plate. Enlarged 6 diameters*

*Fig. 95—Right—Light field photo of above disk on Bakelite plate*

one, and then subtracting one, thus,

$$\frac{1-\cos^3\theta}{(k-\cos\theta)^2} = \frac{(1-\cos^2\theta)+(k-\cos\theta)^2}{(k-\cos\theta)^2}-1$$

$$= \frac{(1+k^2)-2k\cos\theta}{(k-\cos\theta)^2}-1$$

to give

$$S_x = -\frac{2q_o y}{\pi a}\left[\int_0^\pi \frac{(1+k^2)-2k\cos\theta}{(k-\cos\theta)^2}d\theta - \int_0^\pi d\theta\right] \quad \ldots\ldots (156)$$

The integrals in Equations 155 and 156 may be reduced by Peirce's[5] Form 305, to his Form 300. Form 300 is not adaptable as the variable is restricted to values less than $\pi$. The form given in the earlier editions and as given by 199 of the abridged edition, is applicable. Performing the integration by restricting $k$ to values greater than 1

$$S_x = -\left[\frac{a^2+2y^2}{a\sqrt{a^2+y^2}} - \frac{2y}{a}\right]q_o \quad \ldots\ldots (157)$$

$$S_y = -\frac{a}{\sqrt{a^2+y^2}}q_o \quad \ldots\ldots (158)$$

Because of the limits placed on the integration, Equations 157 and 158 are not established for values at $y = 0$, for which $k$ takes on the value of 1. At this value of $y$, these equations give $S_x = S_y = -q_o$. This value can be established as admissible for $S_y$ on the basis of the boundary conditions. $S_x$ may be established on the basis of the continuity of the equation. Therefore these equations hold for these values of $y$.

From Equation 153, $S_x$ and $S_y$ are the principal

[5] A Short Table of Integrals, by B. O. Peirce, Third Edition, 1929, Ginn & Co.

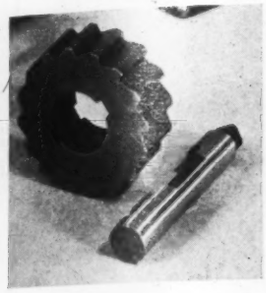


*Fig. 96—Left—Redesign of roller cam and ratchet permitted 75 per cent increase in loading*

stresses. The principal stress difference, $Q$, will then be given by

$$Q=\frac{2y}{a}\left[1-\frac{y}{\sqrt{a^2+y^2}}\right]q_0 \qquad (159)$$

and the maximum shear stress equals $\frac{1}{2}Q$.

Because the roller is under plane strain there is a stress in the third direction, $S_z$. This is obtained from Equation 32 in an earlier section[6]

$$S_z=\lambda(s_x+S_y)=-2\lambda\left[\frac{\sqrt{a^2+y^2}-y}{a}\right]q_0 \qquad (160)$$

It now remains to determine $q_0$ in terms of $P$, the total load. This may be obtained by summing up the distributed load and equating to $P$. From *Fig.* 87

$$P=\int_{-a}^{a}qbdz=\frac{2bq_0}{a}\int_0^a\sqrt{a^2-z^2}dz$$

$$P=\frac{1}{2}\pi abq_0 \qquad (161)$$

We now have sufficient material for design. The last article developed

$$a=\frac{N}{\beta}q_0 \qquad (150)$$

in which

$$\beta=\frac{1}{2}\left(\frac{1}{r_1}+\frac{1}{r_2}\right) \qquad (136)$$

$$N=\frac{1-\lambda_1^2}{E_1}+\frac{1-\lambda_2^2}{E_2} \qquad (149)$$

to which should be added Equation 161 above. Solving Equations 150 and 161 for $q_0$ in terms of $P$

[6] MACHINE DESIGN, March, 1941.

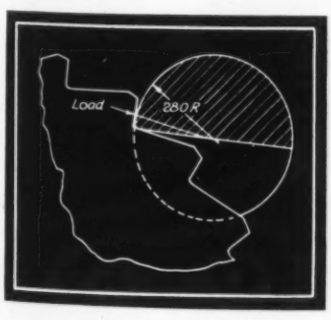



*Fig. 97—Left—Original design of roller pawl and ratchet*

$$q_0=\sqrt{\frac{2\beta P}{\pi Nb}} \qquad (162)$$

The method of solution is now to evaluate the form factor $\beta$ from Equation 136, the elastic factor $N$ from Equation 149, and substitute in 162 to determine $q_0$. With $q_0$ determined, $a$ is found from Equation 150. It is advisable always to check to see that $a$ is small relative to $r_1$ or $r_2$ and $b$.

The above design data has been collected in *Fig.* 88, together with a diagram illustrating the various quantities. This figure is complete in itself and self explanatory with the following relations and table of elastic constants:

**Elastic Constants**
**(from various sources)**

| Material | $E/10^6$ | $\lambda$ | |
|---|---|---|---|
| **Steel,** except high alloy tool steels, etc. | 29 | .30 | |
| **Commercial Malleable Iron** | 25 | .28 | (estimated) |
| **Bearing Bronzes** | 14 | .35 | |
| **Commercial Cast Iron** | 12 | .25 | |
| **Aluminum** and its alloys | 10.3 | .35 | |
| **Gun Metal Bronze** | 10 | .35 | (estimated) |
| **Copper**—not cold worked | 10 | .35 | (estimated) |
| **Photoelastic Bakelite** | .6 | .35 | |

$$\beta=\frac{1}{2}\left(\frac{1}{r_1}+\frac{1}{r_2}\right)$$

$$N=\frac{1-\lambda_1^2}{E_1}+\frac{1-\lambda_2^2}{E_2}$$

in the above, $r_1$ is the smaller roller. When one roller is a plane, $1/r_2$ is zero, making $\beta=\frac{1}{2}r_1$.

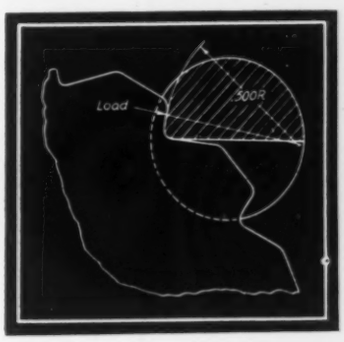



*Fig. 98—Right—Redesign of roller pawl and ratchet. Increase in radius of contact surface permitted three-quarter increase in load*

When one "roller" is a circular seat, its radius is considered negative, giving

$$\beta=\frac{1}{2}\left(\frac{1}{r_1}-\frac{1}{r_2}\right)$$

Values for $q_0$ and $P'$ are

$$q_0=\sqrt{\frac{2\beta P}{\pi Nb}}$$

$$P'=\frac{P}{br_1}=\frac{\pi Nq_0^2}{2\beta r_1}$$

where $P'$ is the load per inch of length per inch of smaller radius. Also,

$$a=\frac{N}{\beta}q_0=\frac{2P}{\pi q_0 b}$$

$$a'=\frac{a}{r_1}=\frac{.637P'}{q_0}$$

$Q_{max}=.601/q_0$ and the maximum subsurface shear is $\frac{1}{2}Q_{max}=.3q_0$ located $.786a$ below the surface. $\lambda$ will vary from .25 to .35.

(*Continued on Page* 114)

# Combatting Problems in Design of Processing Machines

By A. Grodner
*Blaw-Knox Co.*

STRESS determination, heating and agitation are problems of the chemical engineer that are of vital concern to the mechanical designer. Specification of materials for corrosion resistance and strength at extreme temperatures has been discussed in "Specifying Materials in Design of Pressure Vessels" in MACHINE DESIGN for August.

Best illustrative of the considerations involved in the design of such processing apparatus are autoclaves. This single type of equipment embodies practically all the problems encountered by the engineer in designing equipment for the chemical industry.

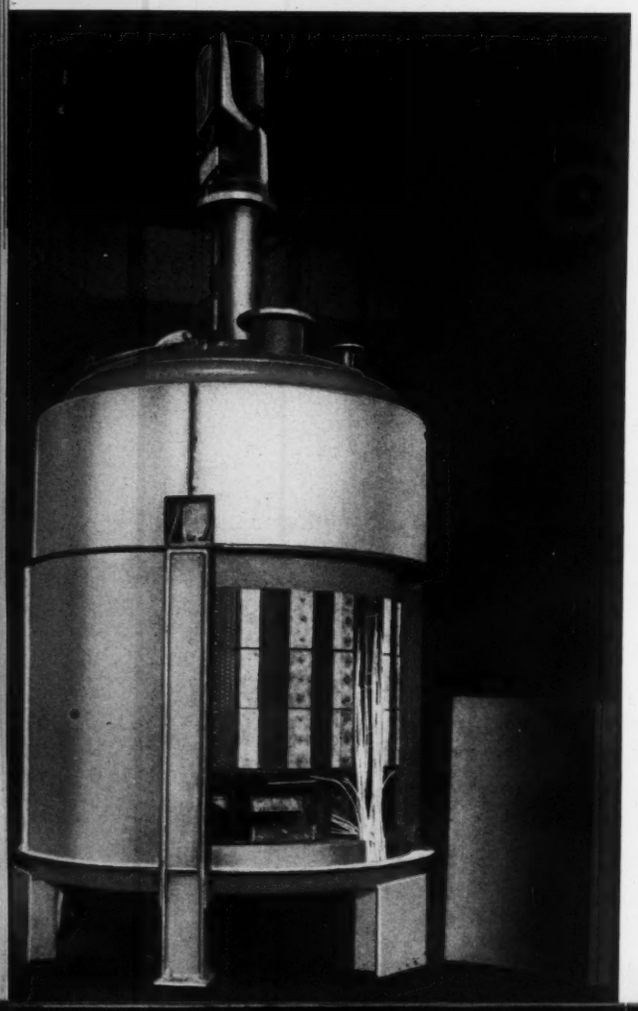


*Fig. 1—Electric heaters connected in several circuits provide increased flexibility of heating*

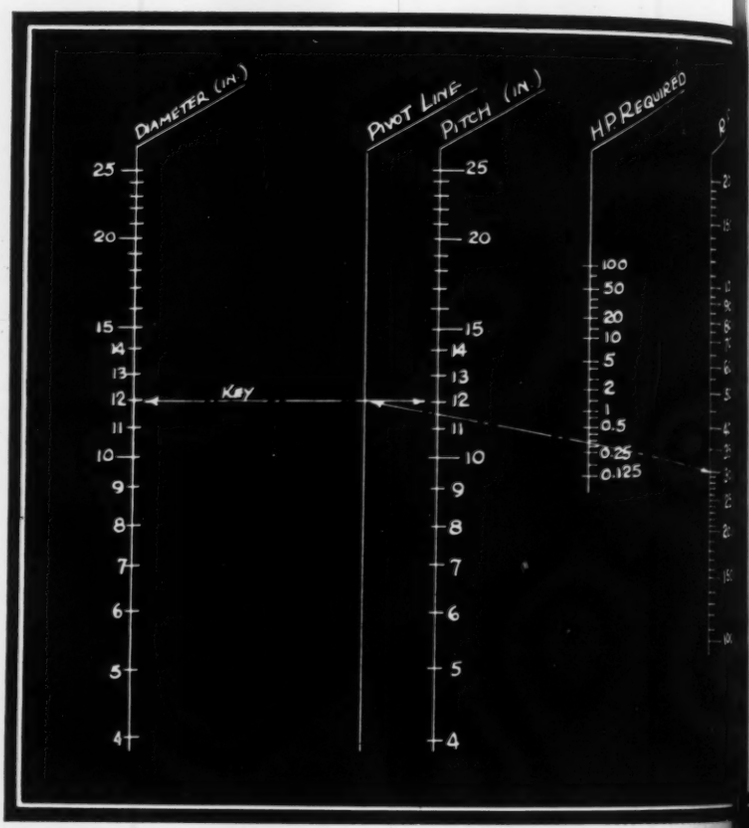



*Fig. 2—Power consumption of propeller type mixers as calculated with the chart is lower than that for the turbine type*

Autoclaves are closed vessels in which chemical reactions take place under conditions of high pressure, high temperature, or the combination of the two factors. These reactions may, in addition, be further accelerated by the agitation of the charge. Hence, the principal elements which the engineer must analyze in the design of a high-pressure autoclave are:

(A) Materials of construction
(B) Allowable working stresses
(C) Methods of heating the charge
(D) Methods of agitating the charge.

(A) MATERIALS OF CONSTRUCTION: Some of the common materials employed in the construction of a high-pressure autoclave were discussed in the previous article. For normal range of temperatures (—20 to +650 degrees Fahr.) it was

seen that the plain carbon steels are satisfactory; for higher temperatures the carbon molybdenum steels retain their safe tensile strength; at subzero temperatures the nickel steels not only retain their tensile strength, but exhibit very good ductility and resistance to impact.

In many chemical processes, reactions with hydrogen gas are becoming increasingly numerous, and here the engineer is confronted with the phenomenon of hydrogen penetration through most carbon steels, which takes place at a rapid rate at high pressures (1000 pounds per square inch and over) and high temperatures (over 500 degrees Fahr.). Under such conditions, the chrome vanadium steels have been found quite adequate. One such alloy steel, SAE 6130, contains .80-1.10 per cent chrome, .15-.18 per cent vanadium, .50-.80 per cent manganese and .25-.35 per cent carbon. It has an ultimate tensile strength of 100,000 pounds per square inch. The 18-8 chrome nickel stainless steels are also satisfactory but, of course, also more costly except where the design of the autoclave lends itself to a stainless steel lining or to the use of stainless clad steel.

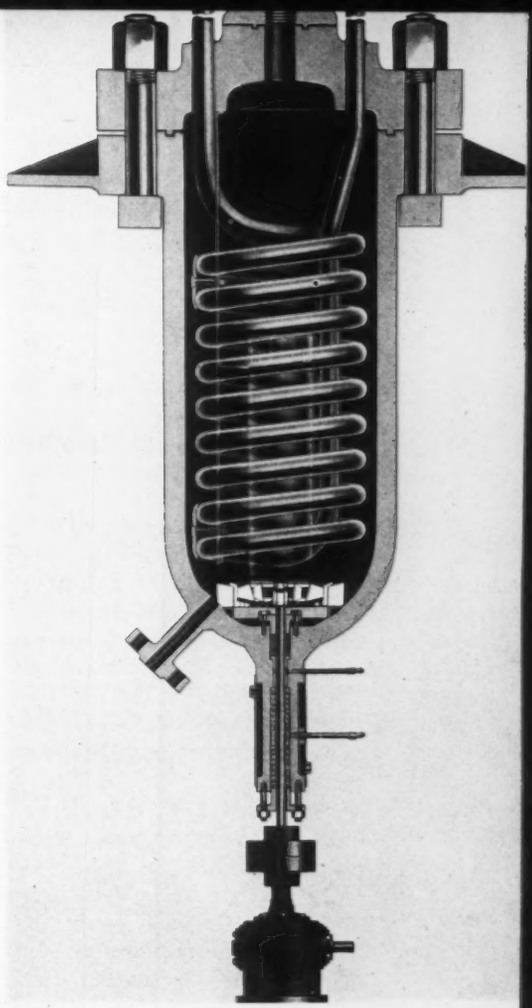


*Fig. 4—Coiled pipe combined with means for adequate circulation affords an efficient method of heating autoclave units*

## Thick-Walled Cylinder Formula for High Pressures

(B) ALLOWABLE WORKING STRESSES: In the previous article working stresses and computations of wall thickness for vessels operating within normal pressure ranges (less than 1000 pounds per square inch) were reviewed. When, however, higher pressures are encountered, such that the computed thickness of the wall exceeds 10 per cent of the inside radius of the cylindrical shell, in the formula $t = PR/SE$, we must treat the autoclave body as a thick-walled cylinder, and the results obtained from this formula are not adequate. The A. S. M. E. code now recognizes the Lame equation for such conditions, where

$$t = R\left(\sqrt{\frac{SE+P}{SE-P}} - 1\right)$$

in which $t$ = thickness of cylindrical shell (inches), $R$ = inside radius of cylinders (inches), $S$ = allowable working stress (pounds per square inch), $E$ = efficiency of longitudinal seam per cent, $P$ = maximum working pressure (pounds per square inch).

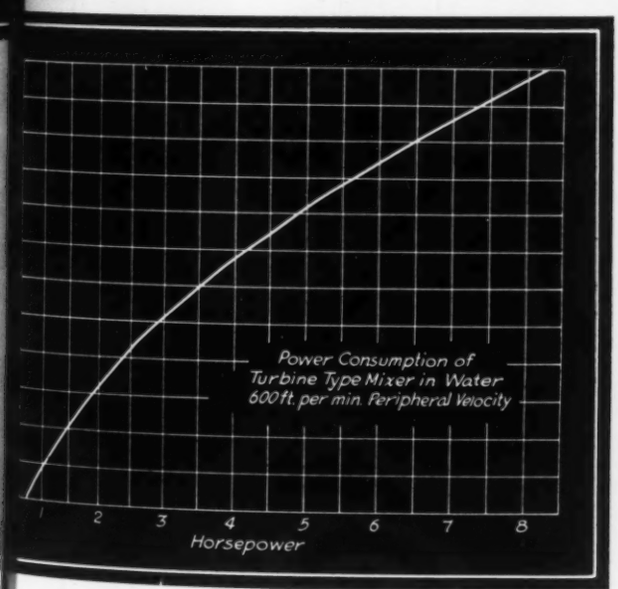



*Fig. 3—Power consumption of turbine type agitators with respect to rotor diameter departs little from linear in the higher power range*

Thus, if we were to design an autoclave with a 24-inch inside diameter, for a maximum working pressure of 3000 pounds per square inch at 500 degrees Fahr., employing a high tensile carbon steel such as ASTM-A-212 (70,000 pounds per square inch minimum tensile strength) utilizing a technique of welding which allows 90 per cent efficiency of the longitudinal joint (Class I construction, paragraph U-68 of the A.S.M.E. code), the thickness of the wall will be

$$t = \frac{24}{2}\left[\sqrt{\frac{\frac{70{,}000}{5}\times .90 + 3000}{\frac{70{,}000}{5}\times .90 - 3000}} - 1\right]$$

$$= 3.30 \text{ or } 3\text{-}5/16$$

The previous formula would have resulted in a wall thickness of only 2⅞ inches.

In addition to the specification of longitudinal joint efficiency, the above indicated paragraph of the code stipulates other controlling considerations in Class I pressure vessel construction. Among these are: Tension tests, bend tests as well as "nondestructive" tests such as those made by X-rays or gamma rays. Number, location and form specimens for both the tension and bend tests are fully covered as is also the allowable size

and number of weld inclusions as determined from X-ray photographs or "radiographs."

With heavy-walled cylinders care must be exercised to avoid too rapid heating of the autoclave body from its exterior, since excessive thermal strains may be induced within the body which at times may exceed in magnitude those resulting from the internal pressure.

(C) METHODS OF HEATING THE CHARGE: The choice of the means of heating the autoclave must be governed by several important factors: Temperatures to be attained, time in which these temperatures must be reached, necessity for accurate control of the temperatures desired, existing facilities, and cost and availability of the heating media.

The oldest method, and the one still in common use, employed for heating the contents of an autoclave is that of direct firing by means of natural or manufactured gas or fuel oil—circulating the hot products of combustion around the autoclave body. The advantages of high temperatures which can be attained, low initial cost, and moderately low heating cost are offset by poor temperature regulation, considerable fire hazard, and difficulty of quick cooling of the charge.

Hot oil, heated in a direct-fired furnace and circulated through a jacket surrounding the autoclave body by means of a pump, is often utilized. Such a heating system has the advantage of good temperature control, moderate or even good economy (depending upon the local cost of oil) and low pressure. The latter is an important consideration, since the autoclave body is not thereby subjected to a high collapsing pressure. Against these good qualities must be arrayed the low overall heat transfer coefficient of hot oil, and a limit of about 600 degrees Fahr. to which the oil can be heated before carbonizing. Thus a maximum operating temperature in the autoclave of about 500 degrees Fahr. cannot be exceeded with this method of heating.

By far the most common method of heating an autoclave is by the circulation of saturated steam through an outer jacket. Steam is usually available in a chemical plant, so that very little additional equipment is required for such heating. The overall coefficient of heat transfer between condensing steam and the liquid charge within the autoclave is high, and the temperatures attained can be regulated by the steam pressure. However, with normal steam pressures of about 150 pounds per square inch corresponding to a temperature of 365 degrees Fahr., the maximum operating temperature in the autoclave is limited to about 350 degrees Fahr. An increase of steam pressure to 250 pounds per square inch results in a temperature of only 405 degrees Fahr. and this slight gain in temperature must be paid for dearly in heavier jacket wall thickness as well as in even greater internal wall thickness, because of the higher collapsing pressure.

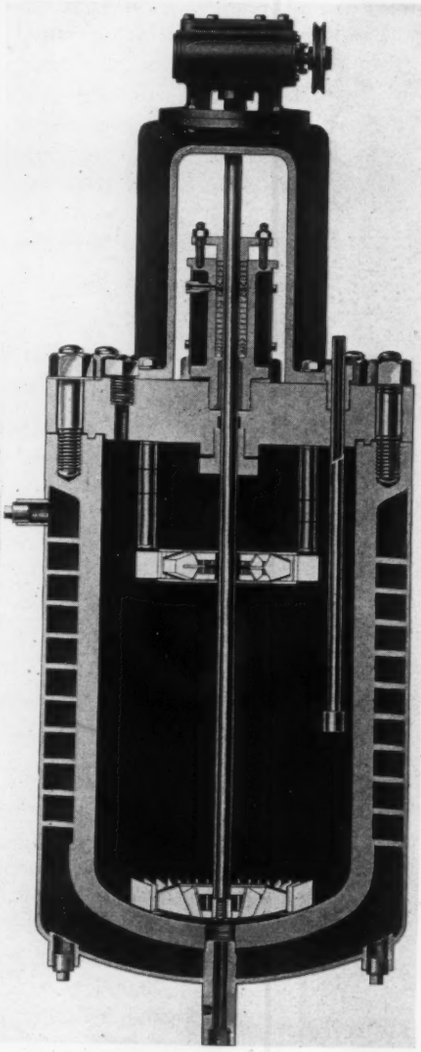


*Fig. 5—Application of water cooling to autoclave packing glands extends life of packing*

For temperatures up to 750 degrees Fahr. either diphenyl, or Dowtherm (a mixture of approximately 73.5 per cent diphenyl oxide and 26.5 per cent diphenyl) has been found satisfactory. At atmospheric pressure Dowtherm vapor has a temperature of 500 degrees Fahr.; at 30 pounds per square inch, a temperature of 600 degrees Fahr.; at 135 pounds per square inch, a temperature of 750 degrees Fahr. For liquid Dowtherm systems (525 degrees Fahr.) the material is heated in a direct-fired vertical tube heater, circulated by a pump through the autoclave jacket and then returned to the heater, in a manner similar to a hot-oil circulating system. The maximum autoclave working temperature possible with this method is about 475 degrees Fahr. For higher operating temperatures a vapor system is installed wherein a gas or oil-fired boiler generates the vapor to temperatures as high as 750 degrees Fahr. (corresponding to a gage pressure of 135 pounds per square inch). As with steam, the vapor transmits its heat by giving up its latent heat of vaporization to the charge.

Electric heating of autoclaves by means of convection heaters clamped to the outer surface of the body has excellent and simple heat control, and provides heat quickly. No auxiliary equipment is necessary; the initial cost is therefore low. Absence of collapsing pressure on the inner autoclave

(*Continued on Page* 120)

MACHINE DESIGN *Editorial*

# Designers' Efforts Should Serve Country As Well As Company

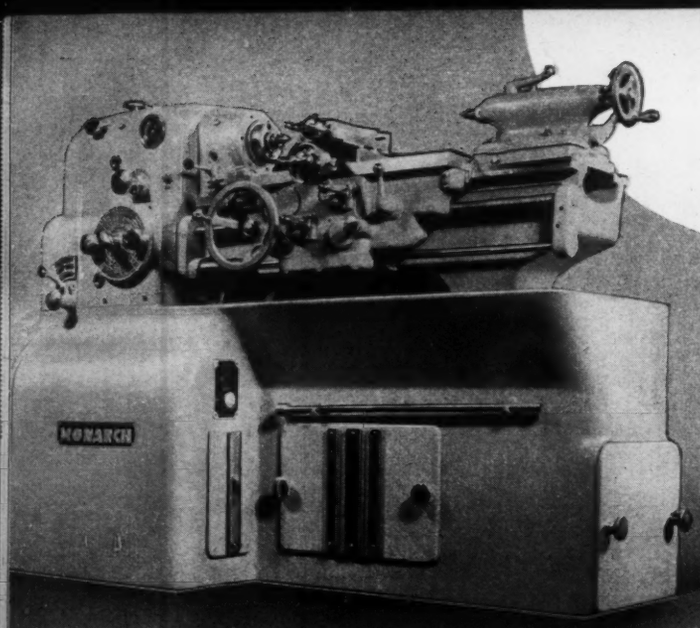
NEVER were designers called on to face as acute a problem as now exists in the selection of engineering materials. Almost every day sees more restrictions imposed. Priorities and rationing are destined to reach a point in the near future at which inevitable hardships will fall on machinery manufacturers who may be unable quickly to adjust their facilities in some measure to war-time production.

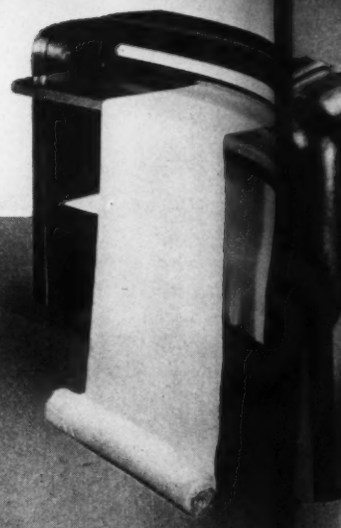
One of the biggest difficulties that already has been encountered is in the selection of substitutes for materials under government control. In many cases companies have chosen adequate substitutes and set up plans for production of the redesigned equipment, only to find that the substitute materials themselves have been put under priority rulings or are likely to fall into that classification later.

One of the best examples of such an occurrence, as a case in point, concerns a manufacturer of machines which involve the use of a considerable amount of aluminum. When this material some time ago was put on a strict priority basis, the company's engineers redesigned their line to make greater use of plastic materials. Restrictions shortly after were placed on plastics, with the result that other materials and methods such as metal stampings now are being given serious consideration.

Situations of this nature, coming in rapid succession, call for more than the average display of ingenuity on the part of designers. Wide knowledge of the properties and characteristics of materials is demanded of those identified with changeovers in design. It is hoped that their task will be made easier by the availability of the directory of materials which precedes this page, and that even though some of the materials included therein are already —or are likely to be—placed on a priority rating, the directory will serve as a worthwhile guide to the choice of others that may meet the emergency condition.

It is also hoped that the directory will prove of value in the conservation of strategic materials to the point that the engineer's efforts not only will be of assistance to his company but to the furtherance of the national defense program.



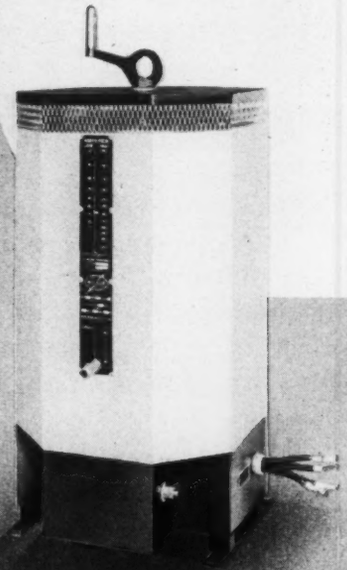



Above—Electric furnace-hardened gears with ground tooth contours constitute entire threading gear train, while a built-in belt-driven stepless speed control is utilized for the spindle drive of Monarch toolmaker's lathe. Instantaneous stoppage of the spindle is accomplished by means of a dynamic brake. Permanent alignment of carriage to wear-resistant hardened and ground bed ways is assured by five self-aligning ball bearings on eccentric studs

# *Design Features* IN NEW MACHINE

## With Special Reference to Choice of Materials

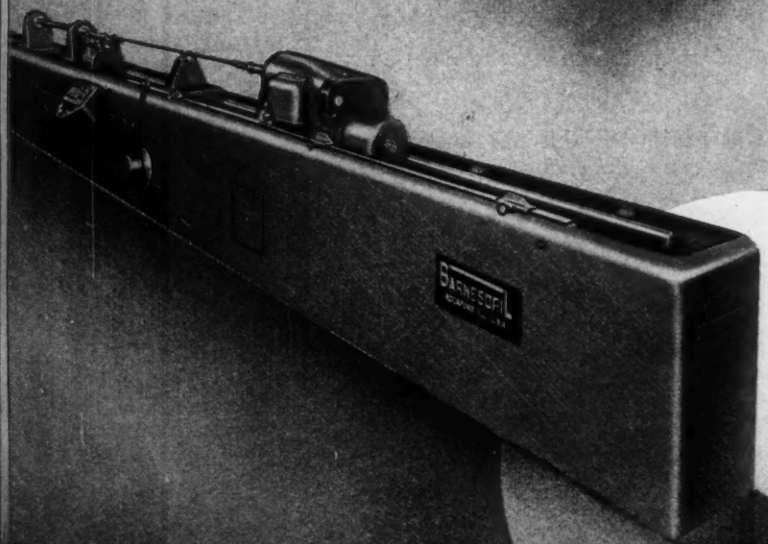
(For new machine listing see page 136)



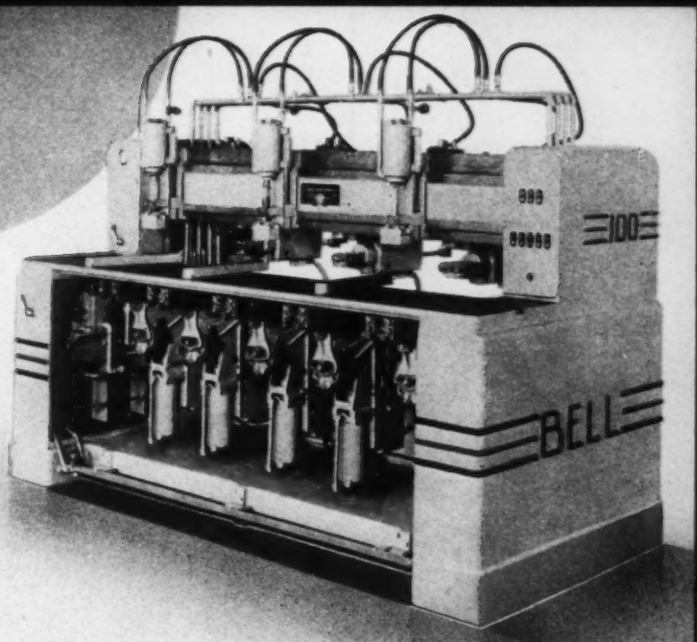
Left—Comparatively small size of large capacity Wi son welder is attributable in part to the use of spu glass, and tape and mica insulation which provide maximum dielectric strength in a minimum of spac Wide range of control provided by six primary an three secondary coils results in unusually cool op eration. Entire unit is enclosed in a sheet steel hou ing finished in baked enamel

Below—Fabricated and welded steel base contributes to lightness and attractive appearance in Barnes honing machine without sacrifice of strength and rigidity. Reciprocating motion of the honing tool is accomplished by a hydraulic system electrically operated. Permanent accuracy of tool guide results from use of longitudinal bars of SAE X1315 steel, case-carburized and hardened

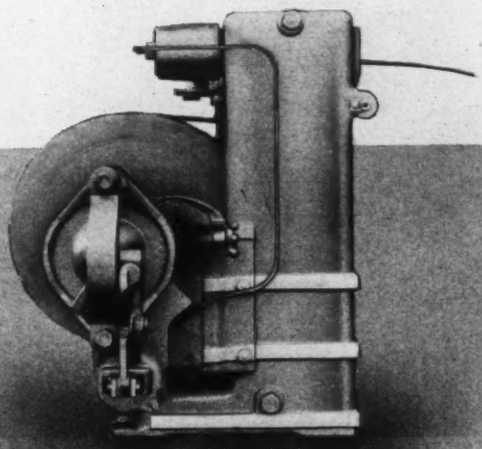
Below—Sound-deadening properties of phenol-res is utilized in the plastic housing of Victor adding ma chine. Complete operating mechanism consists combinations of levers and linkages, all of which a stamped from lightweight materials. Permanent fa tory lubrication of all bearings is possible by use a petroleum lubricant containing colloidal zinc oxid



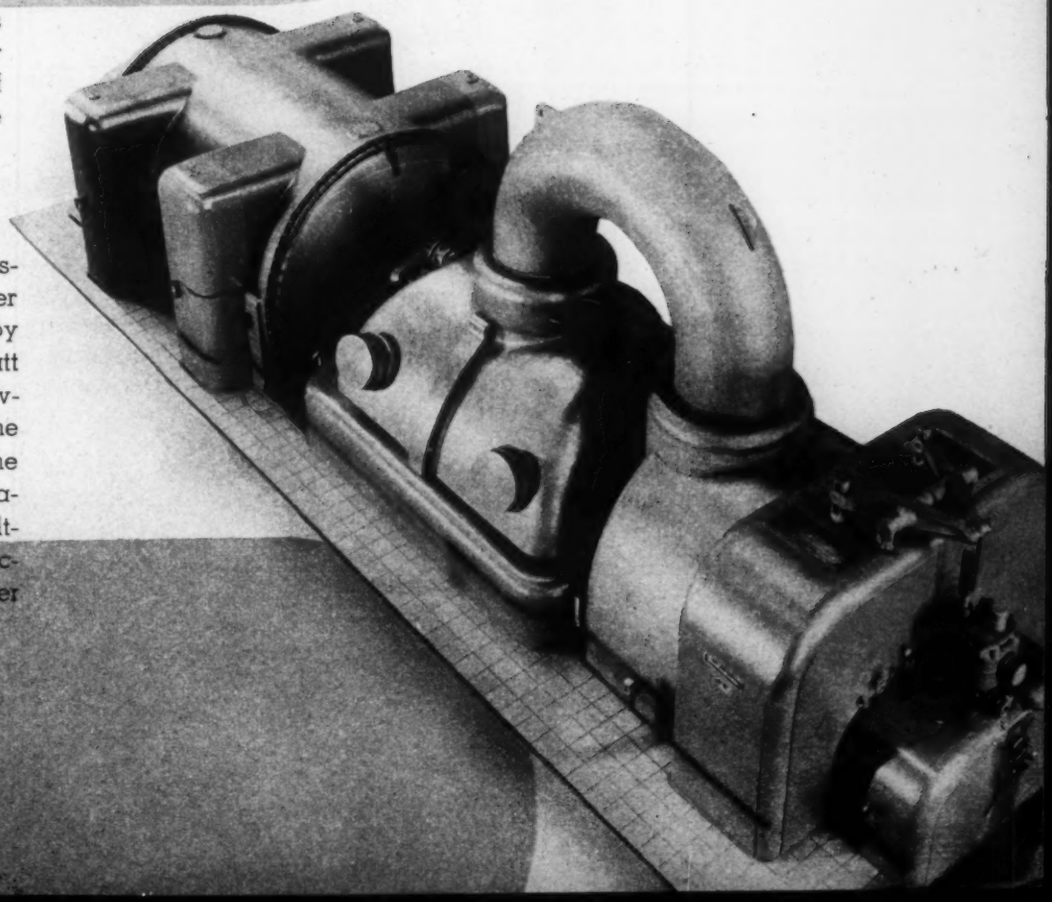
Left—Brush bristles of Ainslie brushing machine are of tempered steel wire made in various gages to accommodate fabrics being processed. Sharpening of the bristles is accomplished by reversing the direction of brush rotation by means of a three-pole double-throw switch controlled by linkages to the starting lever. A built-in reversible motor furnishes the power. Machine finish is brush-applied air-drying enamel




Above—Elimination of mechanical wearing parts is accomplished in Bell post boring machine by the use of pneumatic controls and drives. Hold-down clamps and horizontal boring heads are mounted on the top vertical beam in such a manner that each of the six elements can be adjusted independently. Similar flexibility is obtained in the mounting of the vertical heads in the main table. Each head is powered by its own special built-in motor for drive to the spindle boxes



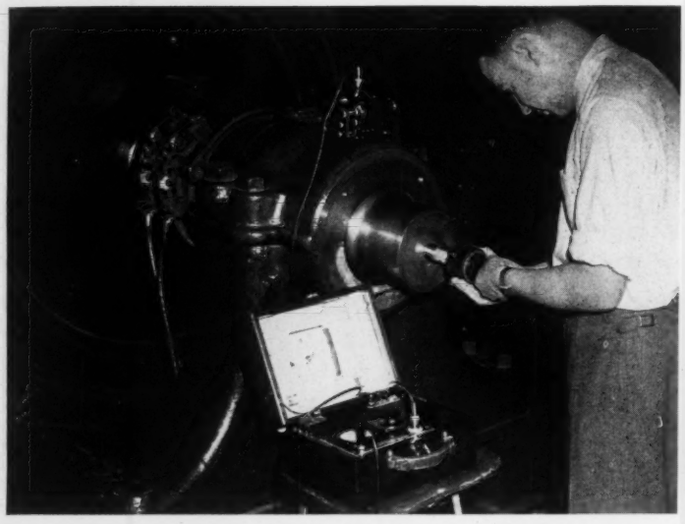
bove—Nerve roll of Johnstone tenon unwinder controls amount of tenon to be applied on the web of maerial through adjustable weights atached to the roll by means of steel ables. Sensitivity of the machine is nhanced by use of a bronze bellows aving a capacity of 200 pounds per quare inch over one-half inch of ravel. Machine housing in which the bellows is mounted is of cast iron



Right—Modern tendency toward pleasing appearance in the design of power plant equipment is well exemplified by blended contours of 35,000 kilowatt Westinghouse turbine generator. Driven by a tandem condensing turbine operating at 800 pounds pressure, the generator is hydrogen cooled. Vibration is minimized by a series of built-in supports, flexible in a radial direction, isolating the stator from the outer frame structure

# Applications

## of Engineering Parts and Materials



### *Balances Rotors Electrically*

DYNAMIC balancing of large rotating masses such as the rotor of the illustrated synchronous motor presents perplexing problems. Often such rotors are too large to be accommodated by any available balancing machine. Cost of dismounting and shipping rotors to a machine adequate for the balancing operation may be prohibitive. Even after balancing, service conditions under load may introduce further variables necessitating arbitrary changes in mass and location of the balancing weights.

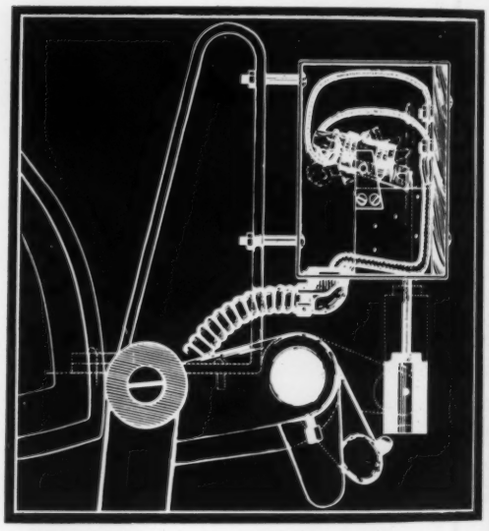
By means of the application of a General Electric sine-wave alternator with a phase-angle adjustment an index to the angular position of balance weights is obtained. A permanent magnet floatingly mounted in field coils then discloses an index to the magnitude.

The magnet assembly is mounted in the coil so that it will reciprocate at a low natural frequency. Hence, when the assembly is in contact with a vibrating mass a voltage will be generated proportional to the magnitude and frequency of the induced vibrations.

### *Switch Halves Power Consumption*

SAVING in power costs amounting to almost fifty per cent have been realized by application of a timer switch in the design of linotype machines. Purpose of the timer is to stop the machine automatically whenever the operator interrupts manipulation for one and one-half minutes. Heretofore when the operator left a machine the wear and power consumption continued.

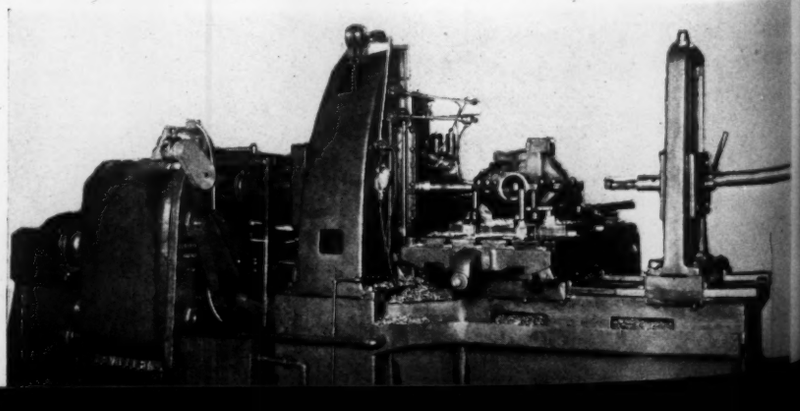
The device itself is simple in its application. A Walser automatic timing mechanism including a mercury switch is used. As illustrated, the mechanism incorporates a gravity-operated dashpot controlled by a stud on the elevator shaft. Raising the weight closes the switch, and as long as the operator continues to set lines the machine keeps running. As soon as he stops, the elevator drops, removing the weight support. As the weight falls the switch is tripped, shutting off the machine.



### *Mill Has Infinite Speed Control*

IMPORTANCE of accurate, infinitely variable speed control has long been recognized in light drives. More recently have these advantages come to be demanded in heavy, slow-speed machines.

Outstanding among such applications is this horizontal boring mill. The driving motor is mounted on a two-speed gearbox the output shaft of which is coupled to the constant-speed or input shaft of a Lewellen vertical transmission.



NO. 1 OF A SERIES

# ZINC IN DEFENSE-

HULL PLATES

RUBBER

BRASS

PAINT

DIE CASTING

CERAMICS

METAL SPRAYING

GALVAN-IZING

PHARMA-CEUTICALS

NICKEL SILVER

U. S. NAVY PHOTO

## AN ATTACK OF CORROSION IS THWARTED!

Most persons do not think of zinc in connection with marine equipment, and yet the United States Navy, as well as independent ship operators, rely on zinc plates to retard the costly corrosion of hulls, boilers and condensers—on vessels which are, today, vital to National Defense.

Because of its relative position in the electrochemical series, zinc in contact with steel in the presence of water will gradually be dissolved, protecting the surrounding area from corrosion. For this reason, it has become common practice to bolt zinc plates directly to the exterior of ships' hulls to provide sacrificial corrosion and save the steel. (Zinc's method of protecting steel by galvanizing involves a similar principle).

The Defense Program requires the employment of all available shipping and the construction of new tonnage in record volume, thereby greatly multiplying the normal needs for hull plates. This use for zinc is typical of the way in which the metal is serving defense without commanding widespread attention.

Actually, the uses of zinc today are no different from those in normal times, but the increased demand on each of the many uses having a part in defense pyramids the load for the zinc industry. Thus it is that manufacturers of non-defense products have not been able to obtain all of the zinc they would like to use. This is part of the price that must be paid for national security.

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THE NEW JERSEY ZINC COMPANY

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# ASSETS *to a* BOOKCASE

### Fluid Mechanics

*By Glen N. Cox and F. J. Germano, professor and assistant professor of mechanics and hydraulics, Louisiana State university; published by D. Van Nostrand Co., Inc., New York; 6 by 9 inches, 274 pages, clothbound; available through* MACHINE DESIGN *for* $3.00 *postpaid.*

A basic, practical treatise on hydraulics, this book approaches the subject of fluid properties and characteristics without recourse to involved abstract hydrodynamic mathematics. Flow of fluids in pipes and open channels follows a comprehensive study of Bemoulli's theorem applied to both compressible and noncompressible fluids.

Application of the Rayleigh and Buckingham methods of dimensional analysis to several specific hydraulic problems does much to clarify the significance of the relation of intangible terms in expressions for characteristics of fluid flow. Discussion of the principles of centrifugal pumps together with practical problems involving their design and operation constitutes a forceful presentation of the effect of basic laws on an actual working hydraulic machine.

□ □ □

### Photoelasticity

*By Max M. Frocht, associate professor of mechanics, Carnegie Institute of Technology; published by John Wiley & Sons, Inc.; 6 by 9 inches, 411 pages, clothbound; available through* MACHINE DESIGN *for* $6.00 *postpaid.*

An excellent, thorough and authoritative treatment of the subject of photoelasticity for the determination of plane stress. A background in strength of materials and an understanding of differential and integral calculus are necessary prerequisites for the reading of this book.

Beginning with a study of stresses and strains in two dimensions based upon the theory of elasticity and including the differential equations of equilibrium, a detailed analysis of polarized light and double refraction together with a discussion of optical instruments follows. Application of the theories of optics and elasticity to photoelastic studies is well illustrated by photographs of loaded plastic models.

Materials, construction and treatment for models are given careful attention as are the various types and kinds of equipment for photoelastic investigation including photography. The book affords a complete reference source for engineers interested in the photoelastic determination of plane stress.

□ □ □

### An Introduction to the Kinetic Theory of Gases

*By Sir James Jeans; published by The Macmillan Co., New York; 6 by 9 inches, 311 pages, clothbound; available through* MACHINE DESIGN *for* $3.50 *postpaid.*

The inimitable style of Sir James Jeans recognizes in this, as in others of his books, that the engineer and neophyte physicist are also human beings who are best impressed by homely demonstrations of natural phenomena. In this book, the kinetic theory is considered in the light of Newtonian physics and is presented with clarity and directness for the engineer.

In scope, the physical properties of gases are exhaustively covered up to the point where the theory breaks down in a Newtonian universe and is again restored by Einstein's conception of the theory of quantum mechanics.

Not written for mathematicians but for engineers, the book does not stress rigorous mathematical proofs but appeals, in the development of the theory, to reason and logic. As such, it is highly recommended to engineers as a basic treatment of the subject.

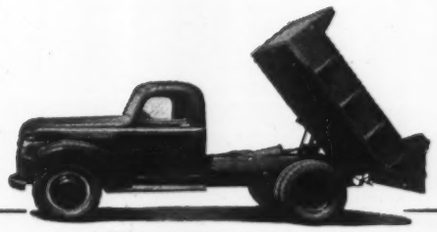
□ □ □

### Descriptive Geometry

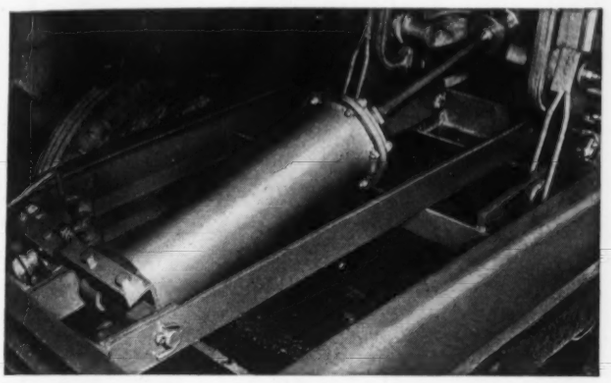
*By Henry W. Miller; published by John Wiley & Sons, Inc., New York; 6 by 9 inches, 254 pages, clothbound; available through* MACHINE DESIGN *for* $2.50 *postpaid.*

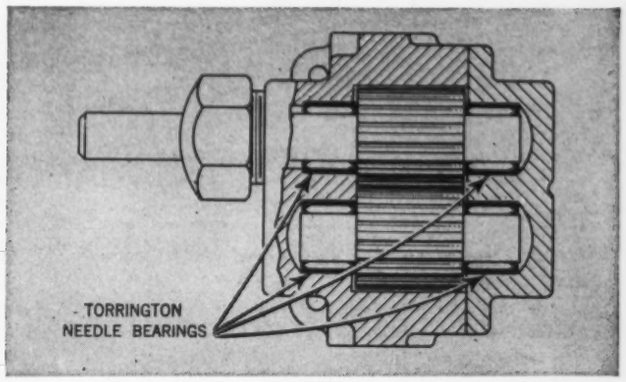
Adapted to the needs of the engineer, the present revision departs from the abstract method of treatment to employ modern adaptation to specific problems. The author deals with each problem in such a way through discussion and illustrations as to enable the engineer to use the book as a reference in the solution of geometric problems of design.

Although shading and shadows are not treated at length, as are the fundamental sections on intersection of surfaces, development of conics, etc., useful information is given enabling the reader to apply fundamental principles from a strictly mathematical standpoint. Perspective is treated in a similar manner. Problems are presented in the last chapter to demonstrate the various principles covered in the book.



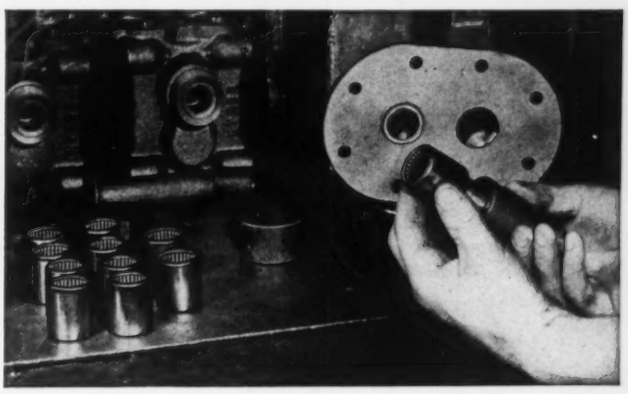
# WEIGHT IS CUT, EFFICIENCY BOOSTED, ASSEMBLY SPED BY NEEDLE BEARINGS IN MARION TRUCKS






**1 THE PUMP IS THE HEART** of any hydraulic mechanism, such as the Marion Dump Truck hydraulic hoist, shown above. "With the use of anti-friction Torrington Needle Bearings, our pumps are cool and efficient in operation," states L. H. Guthery, vice-president of The Marion Metal Products Co.

**2 "SAVINGS IN SPACE** are made possible in the pumps by four Torrington Needle Bearings, which have smaller outside diameters than other bearings of the same high load capacity," Mr. Guthery continues. "These bearings permit lighter housings, less weight, and more payload for our trucks."



**3 "EASY, QUICK INSTALLATION** of the Needle Bearings—which require no complicated bores or expensive lock rings—gives us substantial reductions in costs. We just press the self-contained units into the housings," says Mr. Guthery. Note, above, that simple hand presses are used.

**4 AMPLE LUBRICANT IS RETAINED** over long periods of time in Torrington Needle Bearings because of the close fitting, turned-in lips of their race. This helps the pumps to withstand severely trying conditions and to achieve excellent intermittent service at variable speeds up to 2500 rpm under heavy loads.

Your product, too, may gain important advantages by utilizing the small size, high radial load capacity, lubrication features, and surprisingly low cost of Torrington Needle Bearings. Call on our Engineering Department for full assistance. For detailed information, write for Catalog No. 109. For Needle Bearings to be used in heavier service, write our associate, Bantam Bearings Corporation, South Bend, Indiana, for Booklet 104X.

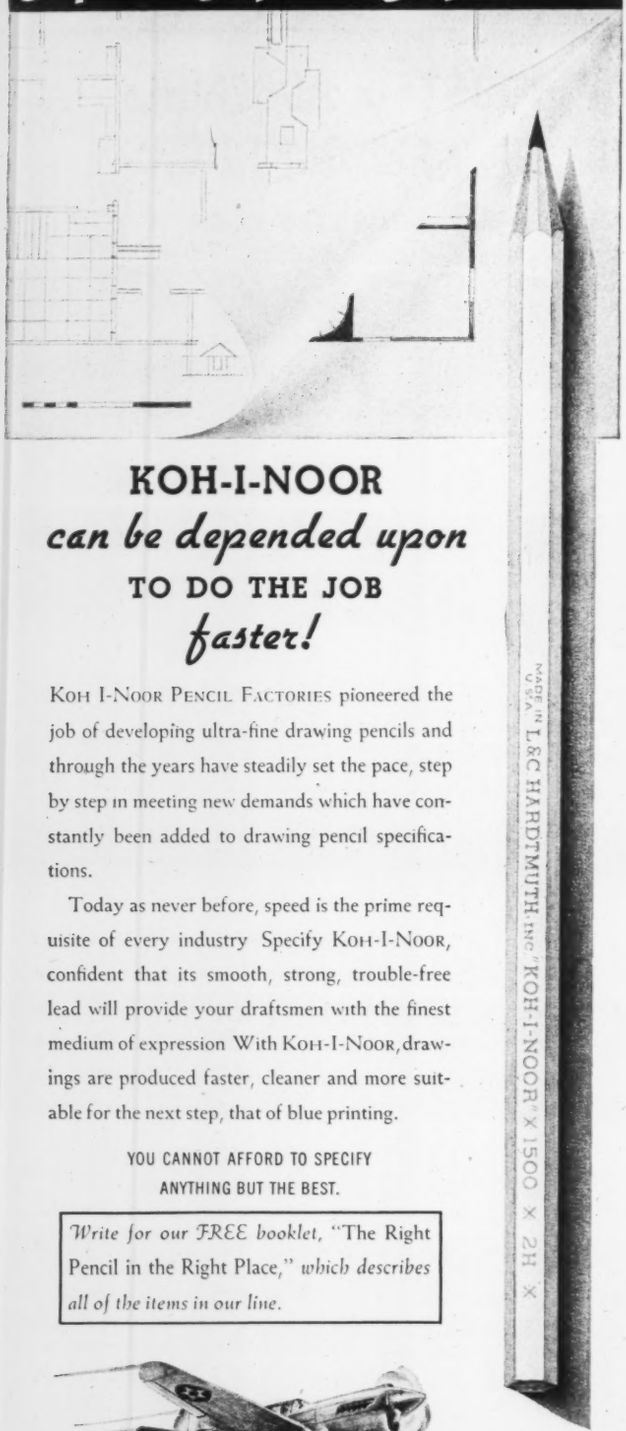
**THE TORRINGTON COMPANY, TORRINGTON, CONN., U. S. A. • ESTABLISHED 1866**

*Makers of Needle and Ball Bearings*

New York Boston Philadelphia Detroit Cleveland Chicago London, England

# TORRINGTON NEEDLE BEARING

Speed Speed Speed

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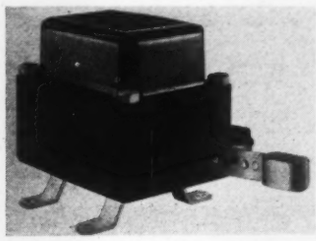
# New PARTS AND MATERIALS

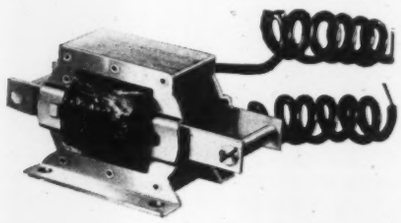
## Float Switch Announced

NEW type explosion-resisting and watertight float switches are now being produced by Square D Co., 4041 North Richard street, Milwaukee. The unit shown in the accompanying illustration is Type 9048AW watertight switch. Enclosure is a heavy cast-iron cover and base. To make it watertight a rubber gasket is provided. The explosion-resisting switch is similar to the watertight float; the surfaces between the cast-iron cover and base are carefully machined to comply with Class 1, Group D hazardous location requirements. Access to the switch chamber is through approved openings by means of closely fitted steel shafts. The switches are available in 110 to 550 volts, alternating or direct current.



## Solenoid Is Improved

DESIGNED primarily for machine tool use, an improved solenoid is being offered by John S. Barnes Corp., 301 South Water street, Rockford,



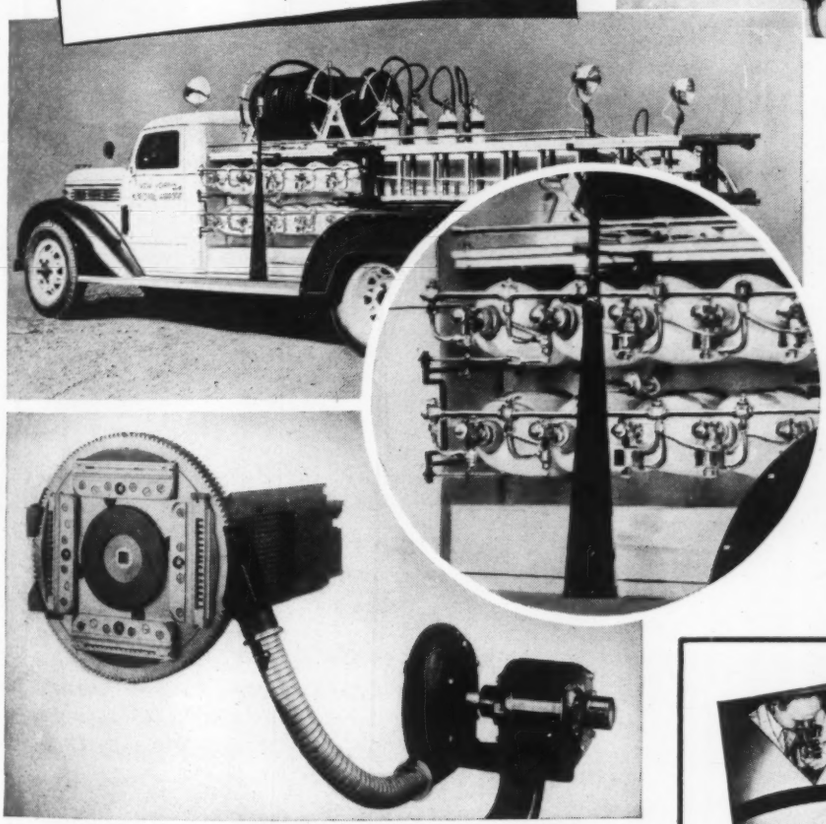
Ill. Compact, rugged and powerful, the new solenoid is unharmed by oil or coolant. The cloth-

# See how problems disappear when *Flexible Metal* hose is used!

Electrical disturbances in aircraft radio were a problem until instrument makers found this economical, dependable means of solving it. It is flexible *aluminum shielding conduit* for low tension wiring. Its use not only ended frequency noises, but because the shielding is extremely flexible, it could be bent around tight places and pushed back into corners. This solution to a typical design problem became a U. S. Govt. specification.

•

When Walter Kidde Co., of Bloomfield, N. J., designed this special crash truck for New York's North Beach Airport, there was one important kink—what to use to connect the series of $CO_2$ tanks you see here? It must be seamless for safety's sake...must be flexible since the tanks were frequently removed for weighing... and must be as durable as the truck itself. The answer, in this, as in thousands of similar cases, was *American Seamless Flexible Metal Tubing.*



The *flexible metal hose* on this blower used in Mergenthaler Linotype machines to bathe linotype molds with cool, clean air in order to keep the temperature just right performs three simple but important functions. Flexible hose can be directed so that air hits exactly where it is needed... it's easier to install... is neat and conserves valuable space.

These and hundreds of other design problems involving flexible metal connectors in the conveyance of steam, air, oil and other liquids and gases have been solved by the products of American Metal Hose. The book illustrated will bring you complete and detailed information on American Seamless, the most dependable flexible metal tubing you can specify. 40245

# American Metal Hose

ANACONDA
from mine to consumer

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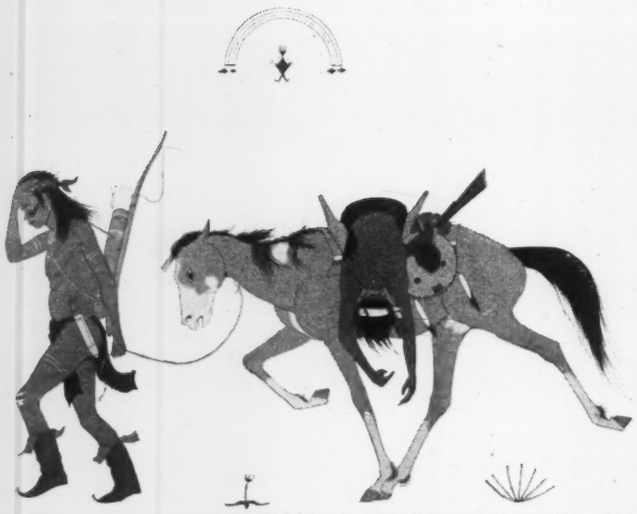
*General Offices: Waterbury, Conn. • Subsidiary of Anaconda Copper Mining Company*
*In Canada: Anaconda American Brass Ltd., New Toronto, Ont.*



from the Original by Allen Houser, Grandson of Geronimo

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taped coil is impregnated with oil and water-resistant varnish. Integral feet and side plates are unusually strong. Heavier rivets are embodied in the new solenoid. To avoid common overheating the solenoid should be used so that any current flow in excess of the minimum is momentary only; and further, the solenoid should not remain energized with a curent of .76 amperes, for intervals in excess of ten minutes even though allowed to cool between intervals. The solenoid is available in 110 volts, 60 cycles, alternating current rating.

## Industrial Multibreaker

FOR economical application as a motor circuit switch or service disconnect switch, Cutler-Hammer Inc., 315 North Twelfth street, Milwaukee, has introduced its new 230-volt industrial multibreaker. It is fuseless, with bimetallic strip actuation, visible trip indication and trip free lever. This quick-make and quick-break breaker is rated at 230 volts from 15 to 100 amperes, and is available in 3-pole, 3-pole solid neutral or 4-pole solid neutral types. Calibration is set and cannot be changed. The breaker is completely enclosed and practically dust-tight.

## Capacitor-Start Reversing Motor

INSTANTANEOUSLY reversible motors for use on cranes, hoists, lathes and many other industrial applications have been placed on the market by Westinghouse Electric & Mfg. Co., East Pittsburgh. This new series of capacitor-start reversing motors is available in ratings of from 1/6 to ¾ horsepower, single phase, 60 cycle, and operates at 1725 revolutions per minute on 115 and 230-volt circuits. No brushes or commutators are used. To reverse the motor a special centrifugal-starting switch with two contacts, a solenoid relay, and a resistor are required. These are furnished as part of the motor. A drum switch must be provided separately to operate the motor. In operating, the

# Let's get some *Vitality* into those "*dry-developed*" prints

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FOR AMMONIA VAPOR PRINTS

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**Dallas**—The Rush Co.
**Dayton**—Gem City Blue Print & Supply Co.
**Denver**—H. R. Meininger Co.
**Detroit**—Frederick Post Co.
**Fort Wayne**—Fort Wayne Blue Print & Supply Co.
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**Houston**—Gulf Blue Print Co.
**Indianapolis**—Indianapolis Blue Print & Litho Co.
**Jacksonville**—A. R. Cogswell
**Kansas City**—Western Blue Print Co.
**Knoxville**—Sehorn & Kennedy
**Los Angeles**—McKinney Blue Print Co.
**Memphis**—Service Blue Print Co.
**Milwaukee**—Frederick Post Co. of Wis.
**New Orleans**—Southern Blue Print Co.
**New York**—John R. Cassell Co., Inc.
Reproduction Print Service, Inc.
**Oklahoma City**—The A & E Equipment Co.
**Omaha**—Standard Blue Print Co.
**Philadelphia**—Philadelphia Blue Print Co.
**Pittsburgh**—American Blue Printing Co.
**Portland**—J. K. Gill Co.
**St. Louis**—Service Blue Print & Photo Copy Co.
**Salt Lake City**—Salt Lake Blue Print & Supply Co.
**Seattle**—Kuker-Ranken, Inc.
**Tampa**—Office Equipment Company
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**Any size from 12" O.D. to 100" O.D.**

YOU get exactly what you specify when you put your requirements for forged and rolled steel rings in the experienced hands of Taylor Forge.

As the world's largest manufacturer of forged steel flanges, Taylor Forge has amassed the finest forging, rolling and machining equipment — exceptional facilities for heat treating — most complete and modern laboratory testing equipment.

The facilities of Taylor Forge are of particular interest to manufacturers whose product requires special heat treating and testing to insure specific characteristics.

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**General Offices & Works: Chicago, P. O. Box 485**
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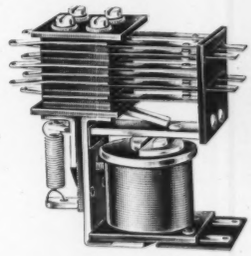
● Other Taylor Forge Products include: "WeldELLS" and related seamless fittings for pipe welding; forged steel flanges; forged steel nozzles, necks and other outlets for pressure vessels; light walled spiral pipe; heavy walled electric-weld and forged-weld pipe; corrugated furnaces, and similar forged and rolled products.


drum switch is closed, setting up a power circuit through the solenoid relay and motor windings. The relay transfers the circuit from the lower to the upper contact and locks the relay across the line. Line voltage across the motor main and starting windings starts the motor. At a predetermined speed, the centrifugal-starting switch opens to disconnect the starting windings, and the motor operates on the main winding as an ordinary single-phase induction motor. The drum switch is thrown to the other side to reverse the motor.

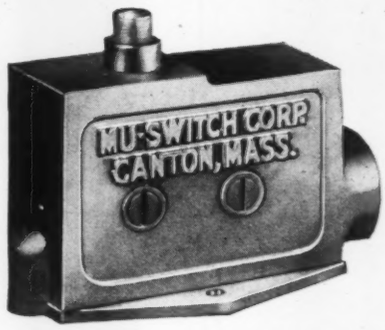
## Small, Compact Relay Introduced

LATEST addition to the relay line of G-M Laboratories Inc., 4314 North Knox avenue, Chicago, is the Type "F" relay capable of giving long uninterrupted service. Available with 1, 2, 3 or 4 poles, either single throw or double throw to operate on alternating or direct current, the relay has contacts which have self-cleaning, wiping action, with heavy contact pressure. Measurements of the relay are: 2¼ inches high, 2½ inches long, and 1⅛ inches wide. This is one of several new relays; others are to be announced in the near future.

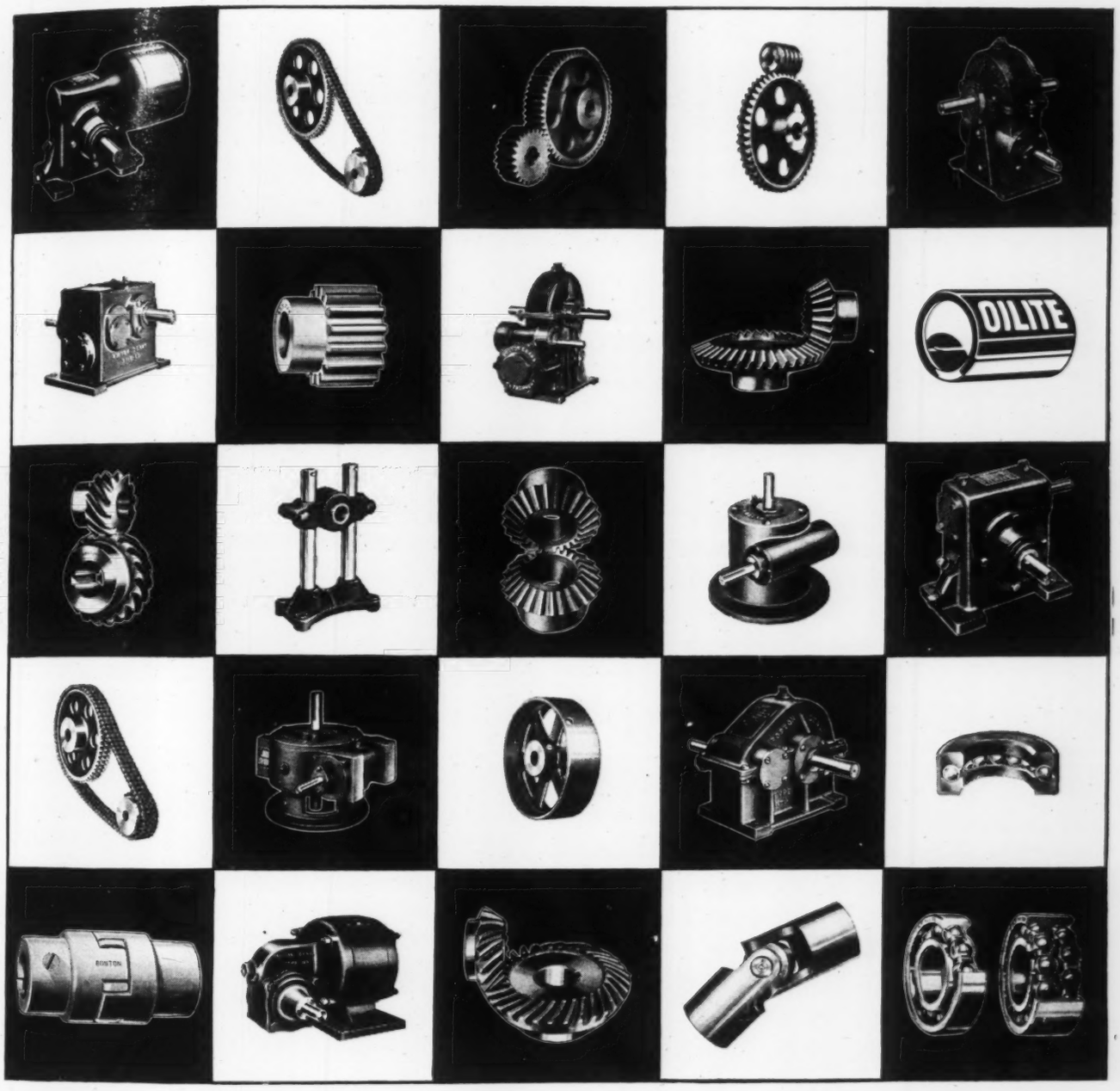


## Switch Has Arc Supressor

FOR industrial and machine tool applications, a new precision, 2-kilowatt direct current switch has been brought out by Mu-Switch Corp., Canton, Mass. In order that it may be installed in conduit




wiring systems this switch, designated as type D, is available in a cast metal housing 1½ x 2¾ x 3½ inches overall. The housing is made of bronze with hub tapped from ½-inch pipe thread for machine tool applications; an aluminum case with male ¾-inch—20 thread; and others to specification. The base, which is readily removable, gives access to the large binding screw terminals. The important feature of this conduit style switch is the built-in,




# Boston Gear Power Transmission Equipment

Designed and built to give you maximum satisfaction at minimum cost. Carried in stock in types and sizes suitable for almost every kind of application involving the mechanical transmission of power.

With the exception of Oilite Bearings, complete descriptions, specifications and list prices of the equipment shown here will be found in the Boston Gear general catalog No. 53. Complete data on Oilite Bearings is contained in a booklet, Form O-4, devoted exclusively to that product.

Your free copies of either or both of these publications gladly sent on request.

## BOSTON GEAR WORKS, INC. NORTH QUINCY, MASS.

# PLASTIC TUBING FOR INSULATION

The use of IRVINGTON IRV-O-LITE XTE-30 and XTE-100 and KOROSEAL EXTRUDED PLASTIC TUBING for insulation is rapidly increasing. Wise manufacturers are realizing its distinct advantages in assembly, performance and low cost.

## AUTOMATIC TRANSPORTATION USES IRV-O-LITE

The Automatic Transportation Company states that IRV-O-LITE XTE-30 is used for insulation between the terminals of their Rotor Brush Truck Controllers.

IRV-O-LITE and KOROSEAL have high dielectric strength, high mechanical strength, and hitherto unattainable resistance to tearing, abrasion, heat, fire, and solvents.

Manufacturing costs are reduced by the smooth inside surfaces and extreme flexibility which enable quick assembly on wire.

**IRV-O-LITE XTE-30 & XTE-100 and KOROSEAL**

Meet rigid electrical, chemical, and physical requirements. Test these tubings yourself. Let us know your requirements and we will send samples best suited for your use and with complete data on types and sizes.

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Irvington VARNISH & INSULATOR CO.

IRVINGTON, NEW JERSEY, U. S. A.

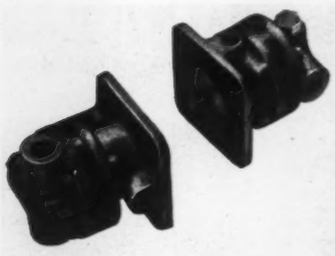
PLANTS AT IRVINGTON, N. J. HAMILTON, ONT., CAN.

Representatives in 20 Principal Cities


blow-out magnet which quickly quenches the direct current arc; thus prolonging contact life and obviating need for condensers or other external contact-protecting devices. In the illustration is shown a DAP switch with compression plunger overtravel mechanism capable of absorbing 5/16-inch overtravel. Other types of actuating mechanisms for the style DAP switch include leaf spring, roller and short-travel plunger.

## Small Nonpulsating Pump

BUILT for long operating periods without attention, a small but rugged nonpulsating discharge pump has been announced by Romec Pump Co., Elyria, O. Available for aircraft and diesel engines of 200 horsepower or less, the pumps have a capacity of 75 gallons per hour at 1750 revolutions per minute. These power-driven fuel pumps are



known as Series RB-4360 and RB-4350. The pumping principle conforms with those of larger design. Permanently set fuel pressure is available within an optional range of 2½ to 20 pounds per square inch. Fuel pressure relief valve and by-pass are integral; the valve springs are interchangeable. Valves are identified according to direction of pump rotation. Drive can be either through square or splined shafts, or the pump may be specially built for other drives.

## Copper Plating Process

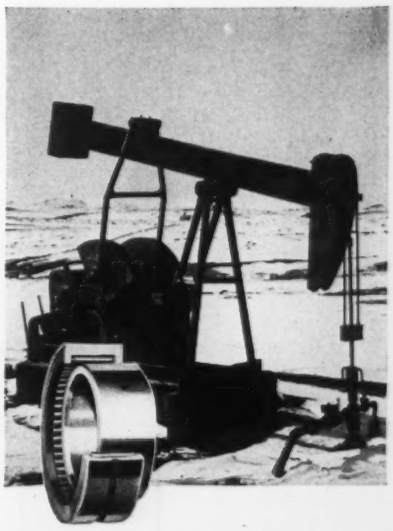
NECESSITY for replacing with copper a large portion of the nickel previously used as one of the base platings for chromium finishes has created many problems. Especially significant, therefore, is the introduction of the Unichrome alkaline copper process, developed by United Chromium Inc., 51 East Forty-second street, New York. This process gives a fine-grained, smooth copper deposit, even in heavy thicknesses. The plating bath is a mildly alkaline bivalent copper solution, operated at a pH of about 8.5 electrometric. The throwing power is excellent. Chemicals used are specially prepared salts, and no brighteners, wetting agents or special additions are necessary. Bath contains no cyanide and ventilation is not required. Time of plating depends on thickness required and current density used. Normally, current densities from

(*Continued on Page* 88)

# IN THE NEWS

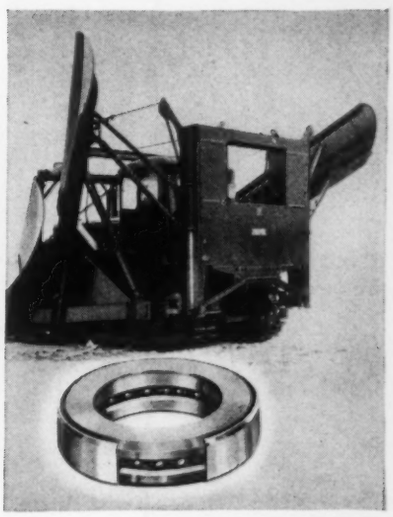
## WITH BANTAM BEARINGS

**ONE OF THE LARGEST GUNS** in use by the Army of the United States is this 155-mm. now being produced by the Pettibone Mulliken Corporation. Entire load of gun as it turns on its mount is supported on a roller thrust bearing manufactured by Bantam for this exacting application. Design of special bearings to meet new and unusual engineering requirements is an important part of Bantam's contribution to national defense and to the solution of industry's bearing problems.

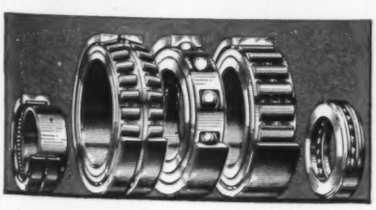


**SIMPLICITY AND STURDINESS** of construction characterize the oil well pumping units built by The Bridgeport Machine Company. Bridgeport selects Bantam Quill Bearings for use on the equalizers of many of its heavier-duty units, because the Quill Bearing combines the advantages of simple construction, high capacity, small size and long life. For further information on this unusual anti-friction bearing write for Bulletin B-104.

**EASY OPERATION** is essential in all types of materials handling equipment. This modern hydraulic Lift Truck manufactured by LYON-Raymond Corporation uses Bantam Ball Thrust Bearings in the head assembly to insure easy response to the steering lever.



**WHEN SNOW PLOWS START TO WORK,** every part is subjected to heavy loads and severe strains —yet must function with the highest efficiency, without risk of failure. Carl H. Frink, maker of Frink Sno-Plows, uses Bantam Ball Thrust Bearings at several points to assure reliable bearing performance.

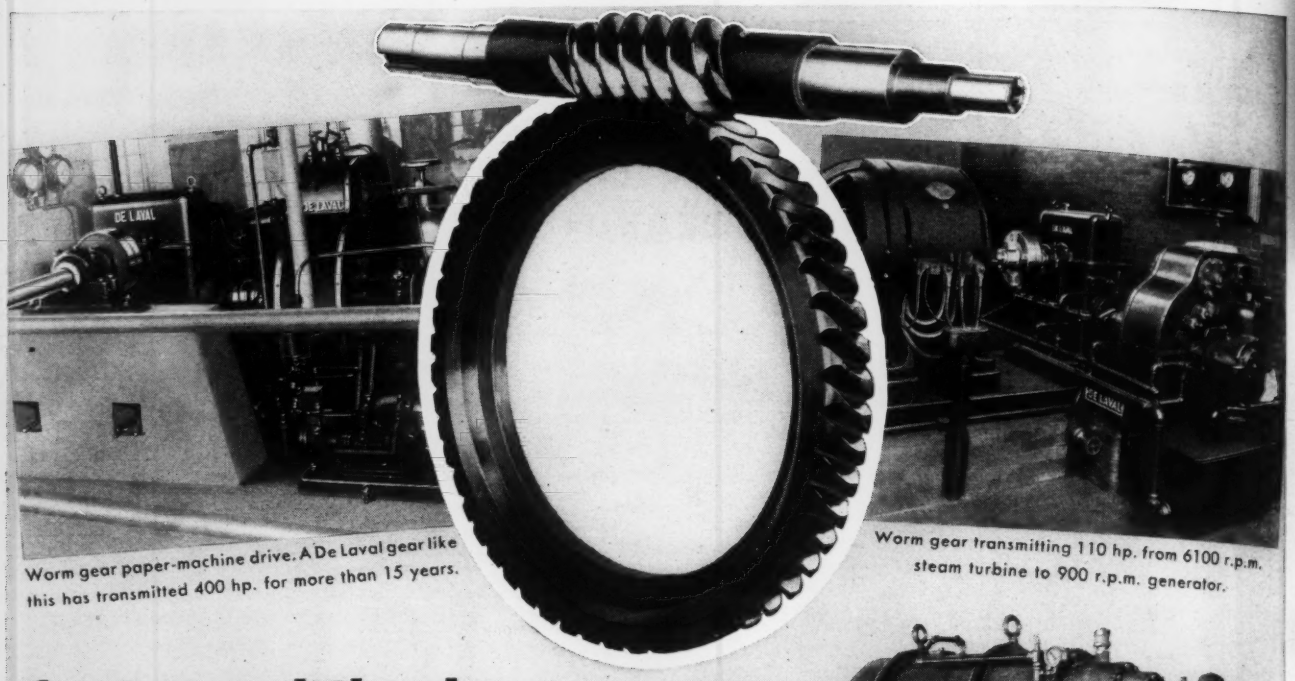


**FOR OUTSTANDING DEFENSE PRODUCTION,** Bantam has received the Navy "E" Award, one of twenty-five presented to U. S. industrial concerns engaged in the manufacture of defense equipment. Backed by long experience in designing and making anti-friction bearings of all major types, Bantam is in an unusual position to help you in selecting the right bearing for *your* requirements. TURN TO BANTAM with your bearing problem.

**BANTAM BEARINGS**

**STRAIGHT ROLLER · TAPERED ROLLER · NEEDLE · BALL**

BANTAM BEARINGS CORPORATION • SOUTH BEND • INDIANA

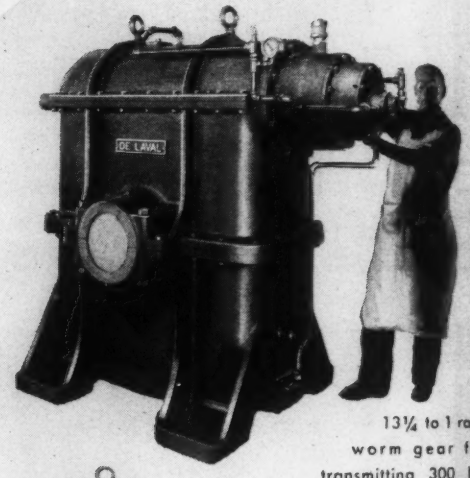


Worm gear paper-machine drive. A De Laval gear like this has transmitted 400 hp. for more than 15 years.

Worm gear transmitting 110 hp. from 6100 r.p.m. steam turbine to 900 r.p.m. generator.

## for transmitting large powers continuously

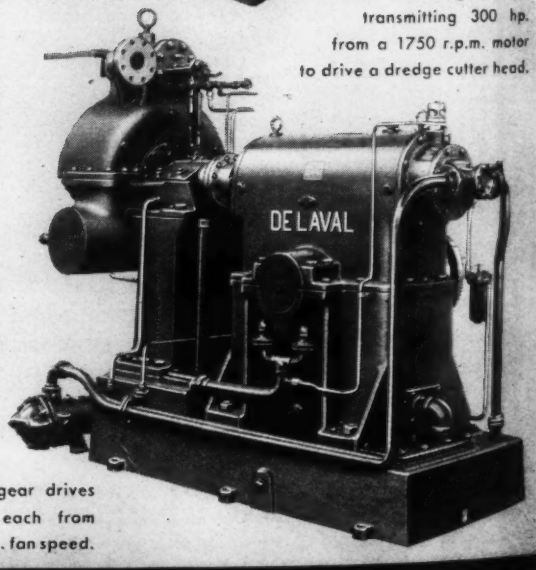
# *select* DE LAVAL WORM GEARS



13¼ to 1 ratio worm gear for transmitting 300 hp. from a 1750 r.p.m. motor to drive a dredge cutter head.

The case hardened steel worms, bearing-bronze wheels, and copious lubrication give long life, without requiring attention other than occasional checking of oil level. The efficiency is high, reaching 97 per cent for certain ratios, and does not recede, but rather improves, with use. The transmission of power is shockless and noiseless.

Our engineers gladly supply data and give competent advice for the solution of speed transformer problems. Ask for Leaflet W-1128.




One of eight steam turbine-worm gear drives of induced draft fans; 185 hp. each from 3760 r.p.m. turbine speed to 550 r.p.m. fan speed.

# DE LAVAL

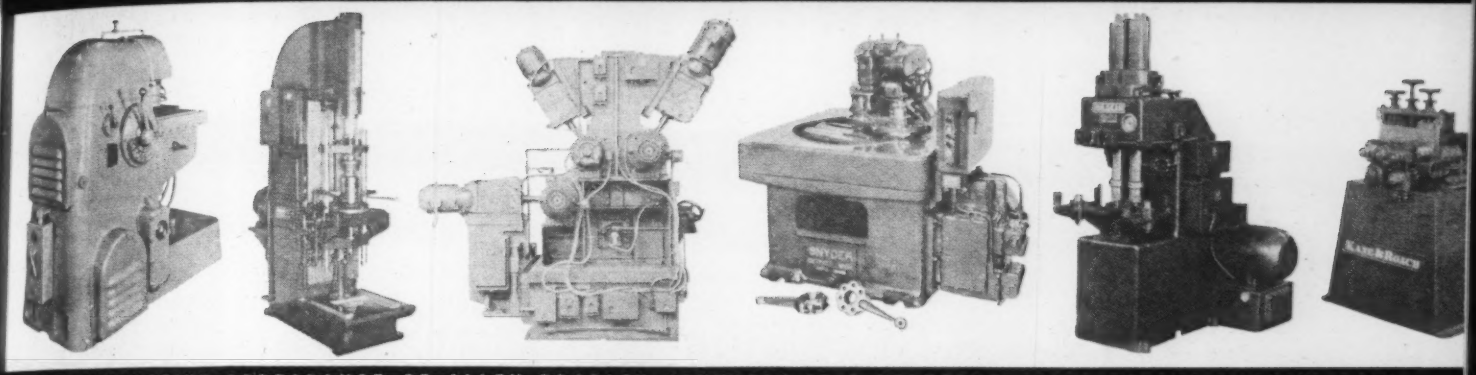
## WORM GEAR DIVISION

**of the De Laval Steam Turbine Co., Trenton, N. J.**

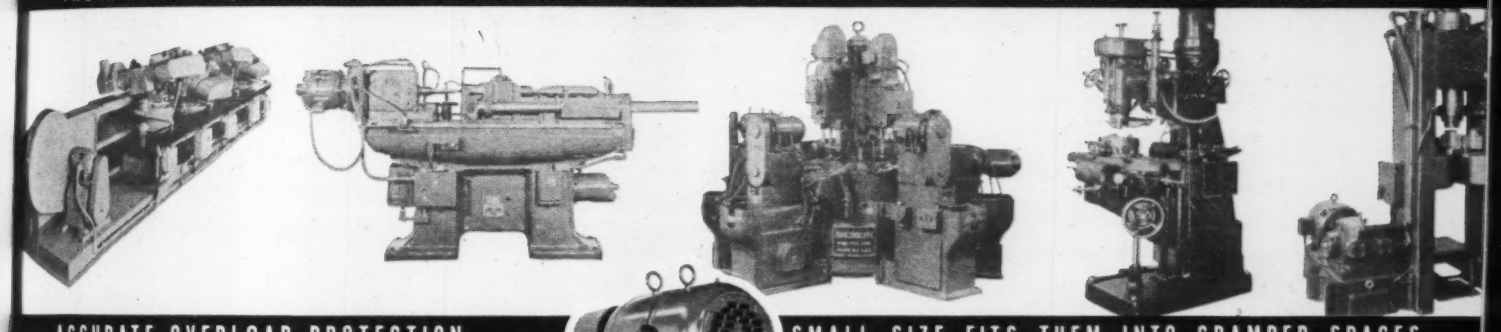
MANUFACTURERS OF TURBINES . STEAM, HYDRAULIC; PUMPS . CENTRIFUGAL, PROPELLER, ROTARY DISPLACEMENT, MOTOR-MOUNTED, MIXED-FLOW, CLOGLESS, SELF-PRIMING; CENTRIFUGAL BLOWERS and COMPRESSORS; GEARS . WORM, HELICAL and FLEXIBLE COUPLINGS

# The Machine Tool Industry

## has gone over in a big way to Allen-Bradley Controls

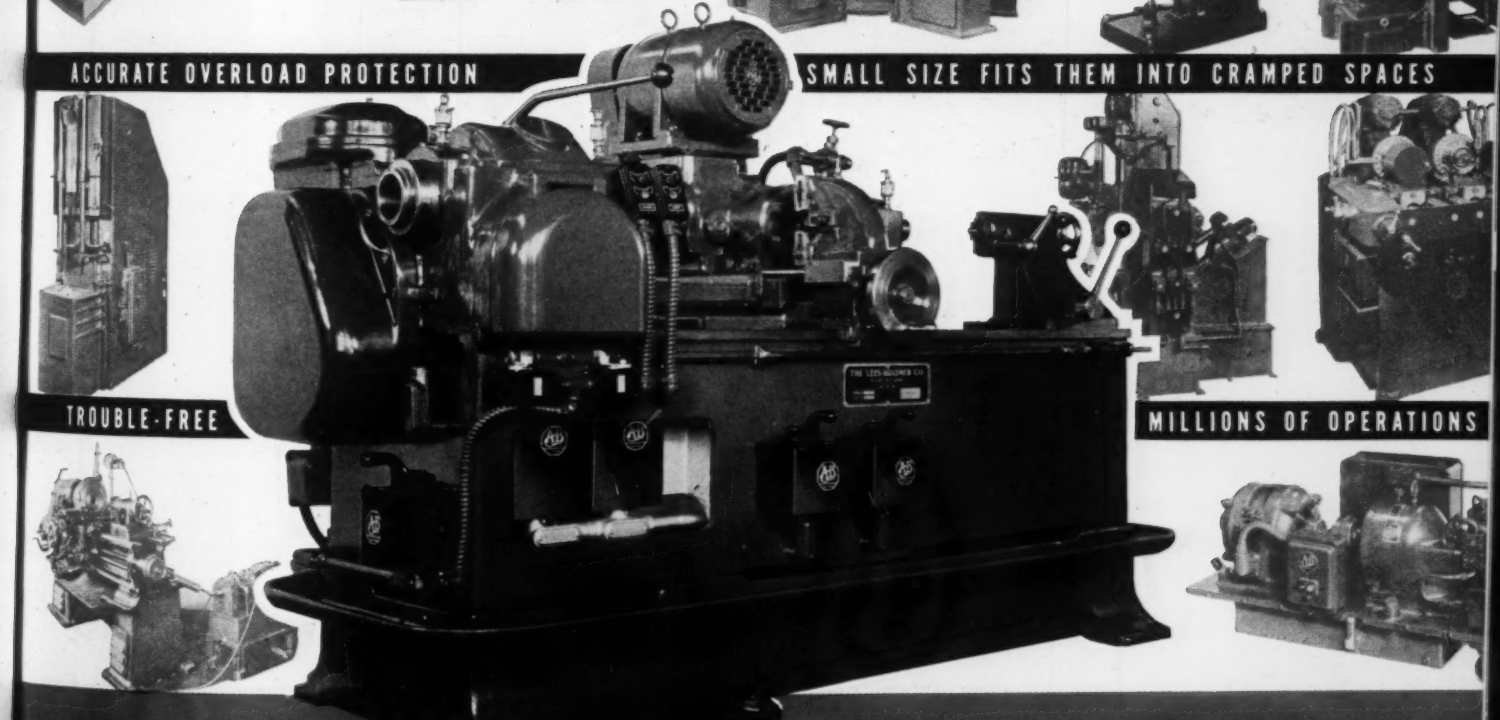


THE ATTRACTIVE APPEARANCE OF ALLEN-BRADLEY CONTROLS IS A VALUABLE ASSET TO ANY MACHINE TOOL



ACCURATE OVERLOAD PROTECTION

SMALL SIZE FITS THEM INTO CRAMPED SPACES



TROUBLE-FREE

MILLIONS OF OPERATIONS

# ALLEN-BRADLEY

## SOLENOID MOTOR CONTROL

QUALITY

The Allen-Bradley Line
offers you a STANDARD Control
for every industrial application
ALLEN-BRADLEY Automatic Starters
BULLETIN 709
ALLEN-BRADLEY Manual Starters
BULLETIN 609
ALLEN-BRADLEY Reversing Switches
BULLETIN 705
ALLEN-BRADLEY Combination Starters
BULLETIN 712
ALLEN-BRADLEY Multi-speed Starters
BULLETIN 715
ALLEN-BRADLEY Automatic Resistance Starters
BULLETIN 740
ALLEN-BRADLEY Drum Switches
BULLETIN 353
ALLEN-BRADLEY Magnetic Relays
BULLETIN 700
ALLEN-BRADLEY Push Buttons
BULLETIN 800
ALLEN-BRADLEY Control Panels
USING STANDARD UNITS
ALLEN-BRADLEY Limit Switches
BULLETIN 801
ALLEN-BRADLEY Semi-Automatic Resistance Starters
BULLETIN 640
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ALLEN-BRADLEY
SOLENOID MOTOR CONTROL
QUALITY

# SHELL BLASTING SPEEDED UP

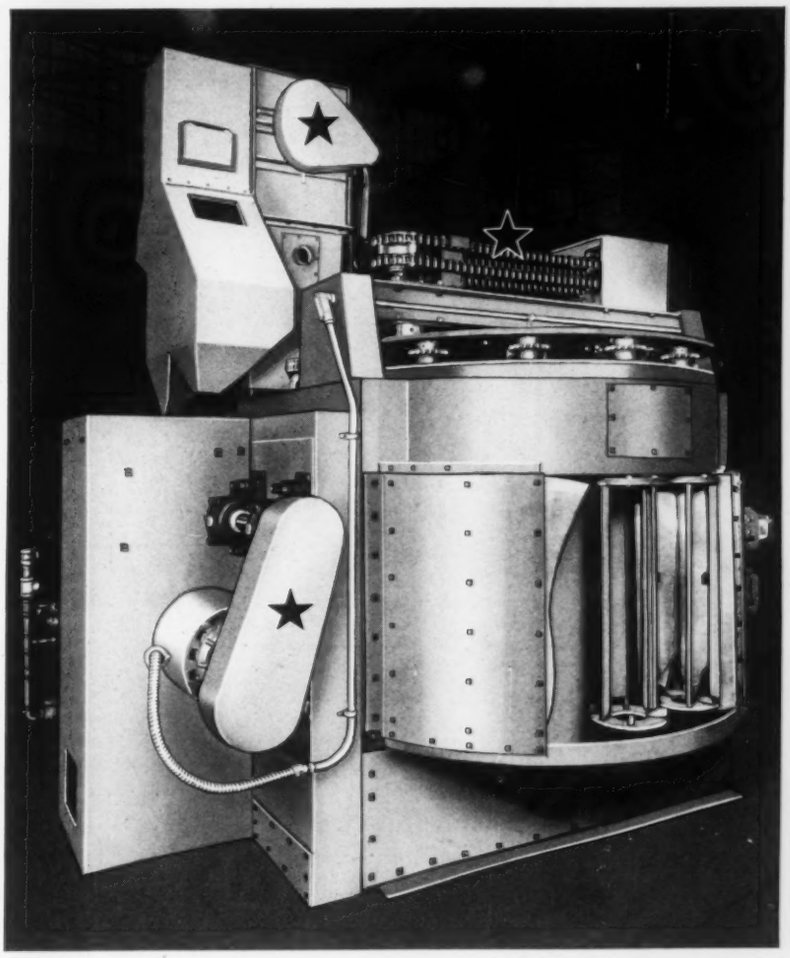
## IMPORTANT ADVANCES IN BLASTING EQUIPMENT

●

## *Faster Descaling at Lower Cost*

●

## DIAMOND Roller Chains Insure Dependable Long Hour Operation

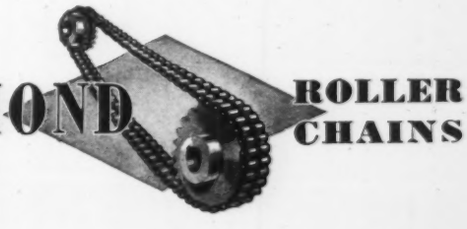


*Front and side view of shell blasting machine, showing loading and unloading position of the Wheelabrator Unit. Photo Courtesy of the maker, American Foundry Equipment Co.*

● Saving shell descaling time speeds up shell production. The faster shell blasting equipment illustrated is not only setting new records but has reduced the cost of descaling materially.

Shutdowns for replacements or adjustments are guarded against in the design and construction—and long-hour continuous operation is assured by the rugged Diamond Roller Chain Drives used for the spinner heads which rotate the shells, move them into position on a time schedule, and operate the elevators which carry the spent abrasives to a separator for re-use.

You may not make shell blasting equipment, but you can improve your machinery performance, too, with dependable, positive, highly efficient Diamond Roller Chain Drives. They never slip or creep. . . . DIAMOND CHAIN & MFG. CO., 435 Kentucky Avenue, Indianapolis, Indiana. Offices and Distributors in All Principal Cities.



☆ DIAMOND ROLLER CHAINS

★ NATIONAL DEFENSE ★
Needs 3 out of every 4

Three out of every four rolls of Arkwright Tracing Cloth made today go straight to defense plants. For head draftsmen in key industrial firms know that permanent transparency . . . quality of finish . . . ease of erasure . . . and ability to take sharp, clear lines in tracing cloth are vital to any production speed-up. These tracing cloth advantages are just as important to the profitable operation of your own business! Write for samples of the Arkwright brands – compare them on all points with the tracing cloth you're now using! You'll see why men who know best are now using Arkwright! Arkwright Finishing Co., Providence, R. I.

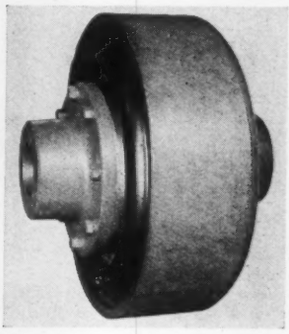
Arkwright
TRACING CLOTHS

(*Continued from Page 82*)

20 to 40 amperes per square foot at a tank voltage of 1 to 2 volts are used, though for some types of work higher current densities and voltages are applicable.

## Hydraulic Centrifugal Clutch

CENTRIFUGAL clutches, recently developed by Fawick-General Co., Akron, O., use as an inflating medium a heavy liquid with which the clutch element is filled, the outlet valve being permanently plugged with a pipe cap. Specific gravity of the liquid is nearly 2. The liquid, in combination with the lead plates provided beneath the asbestos



friction liners, exerts outward pressure owing to centrifugal force. This pressure is used to engage the outer friction surface with the surrounding drum and may be varied by selecting different weights to provide adequate torque capacity at the desired speed. No outside connections such as air or hydraulic lines are necessary. The clutch drum and clutch element are removable without disassembling the driving or driven shafts. A simple, nonmetallic driving connection works entirely automatically and has many of the advantages of a flexible coupling. It is able to take a certain amount of misalignment and also provides for torsional resiliency without slipping.

## Aluminum Paint Substitute

TO SUBSTITUTE for aluminum paint, the Wilbur & Williams Co., Park Square building, Boston, is offering its new line of paints known as Light Gray Totrust. The new paint looks like aluminum paint, and has approximately the same light reflection. Rust can be stopped at its source by the paint as it is a penetrative paint with good protective qualities. The oil in the paint covers penetrating pin holes and rusted pits in metal, expelling any moisture present, surrounding and isolating any particles of rust, and forming a hard, durable and yet flexible film. The paint may also be obtained in other colors for painting over galvanized metals. It has no odor to penetrate food products, is not affected by a range in temperatures from 100 de-

# IN DEFENSE OF BEARINGS

## MILPACO OIL SEALS DO THE EXTRA THOROUGH JOB OF SEALING IN THE LUBRICANT AND SEALING OUT DIRT, DUST AND WATER IN HARD GOING

Milpaco Oil Seals do this extra effective Bearing Protection job because they have their own particular points of design and construction which enable them to do it. And they provide this effective Bearing Protection over exceptionally long periods of time—vitally important these days—eliminating costly and time-consuming tear-downs.

The extra advantage of Milpaco Oil Seals for Better Bearing Protection can be explained to you in detail by a Milpaco engineer. Have him come in and suggest the particular type of seal to use for your equipment.

**MICHIGAN LEATHER PACKING CO.**
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# LARGE
## Precision Hydraulic Cylinders solved this problem . . .

Several recent designs of large broaching machines and other types of machine tools would be impractical without the hydraulic operating cylinders built by Hannifin to meet both the size and the precision standards required. Hannifin cylinders of 11-inch bore, 16 feet long, weighing 3640 lbs. are but one example of large cylinders produced by Hannifin precision methods in regular everyday production.

Big or little, Hannifin cylinder construction and finish is the same for all sizes. Mirror finish honing of the cylinder bore, even in sizes as large as 22 feet long, produces a straight, round, perfectly smooth cylinder interior. High efficiency piston seal, minimum fluid slip, long life, and maximum usable power are the natural results of Hannifin construction features. No-tie-rod design allows removal of end caps without collapse of other parts, and also permits independent positioning of end caps for convenience in installation.

Hannifin hydraulic cylinders are built in seven standard mounting types, with small diameter piston rod, 2 to 1 differential piston rod, or double end piston rod, with or without cushion. All sizes, any length of stroke, for working pressures up to 1000 and 1500 psi. Special types built to order.

*117-inch Cylinder*

*2-inch Cylinder*

Whether you need large or small hydraulic cylinders, investigate the exclusive advantages of Hannifin design and construction. Write for Bulletin 35-MD with complete specifications.

**HANNIFIN MANUFACTURING COMPANY**
621-631 South Kolmar Avenue • Chicago, Illinois

**HANNIFIN**
**HYDRAULIC CYLINDERS**

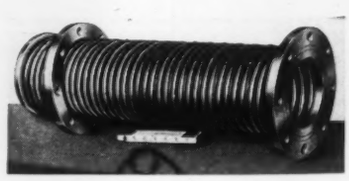

grees Fahr. below zero to 800 degrees Fahr. above zero, and can be applied to damp metal or rusted metal.

### Built-In Time-Delay Relay

FOR controlling motors, valves, gongs or lights in accordance with a predetermined sequence, a time-delay relay has been announced by Eagle Signal Corp., Moline, Ill. The relay, for incorporation as an integral part of apparatus to be controlled, possesses a 4-inch diameter clock face dial and time set pointer for making adjustments. A cycle initiating pushbutton is located in the center of the adjusting knob. The timer can be set to hold a circuit open or closed. Depressing a pushbutton disengages a toothed clutch to reset the timer. By releasing the button, one set of contacts is closed and the second set opened; a clutch is engaged so that a self-starting synchronous motor holds the contacts in position during the preset interval. Coin silver contacts are ⅜-inch diameter by 3/32-inch depth, and open with a snap action. They are rated at 10 amperes at 110 volts, 5 amperes at 220 volts alternating current, noninductive load. Ranges are 120 seconds in 1-second divisions and 20 minutes in 10-second divisions, in two models. Open or enclosed units may be obtained for 110 or 220 volts operation on 25 to 60-cycle alternating current. Surface mounting cabinet is 5¾ x 8 x 4¾ inches.

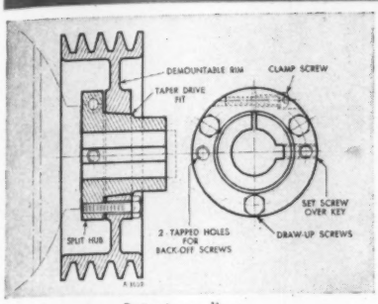
### Seamless Hose Is Corrugated

DISTINGUISHED by its double-thread, helical corrugation construction, a seamless metal hose, type CC, has been developed by Seamlex Co. Inc., 5-19 Forty-eighth avenue, Long Island City, N. Y. The double-thread corrugations insure better distribution of stress and result in greater durability and safety. In the accompanying illustration an anti-vibration tube is shown which measures 6 inches inside diameter and 7¾ inches outside diameter, and 30 inches in overall length. On one end a rigid brass companion flange is brazed, and the other end is provided with a floating flange to facilitate adjustment. Made of bronze, the tubing is suit-

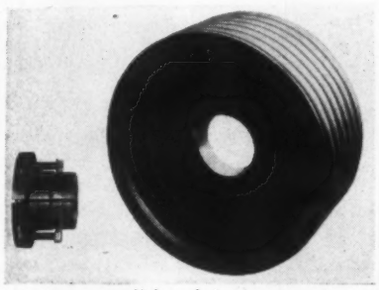


# Speed up production with drive flexibility ...by using WORTHINGTON Q-D SHEAVES

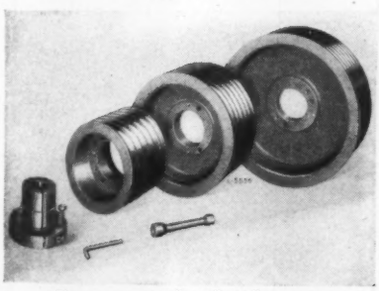
## They give you these 12 BIG PLUS $ VALUES and protection against breakdowns, at no extra cost.



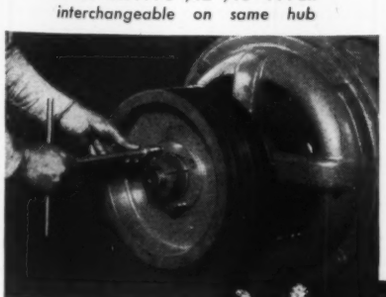

*Patent pending*



*Hub and rim*



*Three rims . . . 8", 12", 16" . . . all interchangeable on same hub*



*Simple . . . quick*

*This method is obsolete. Eliminate it with Q-D Sheaves.* →

## BALANCED DESIGN

1. Overhang stresses reduced 25%.
2. All weave and wobble eliminated.
3. Reduction of bearing loads and shaft stresses on short stub-shaft applications.

## POSITIVE FIT ON SHAFT

4. The equivalent of a press fit.
5. Perfect fit on undersize or oversize shafts.
6. Capacity to handle any shock loads.

## QUICK DETACHABLE RIM

7. Seasonal speed changes made faster, safer, easier, cheaper.
8. Alignment always maintained . . . hub element remains intact on shaft.
9. No wearing parts to adjust . . . simple, fool-proof, trouble-proof.

## QUICK DEMOUNTABLE SHEAVE

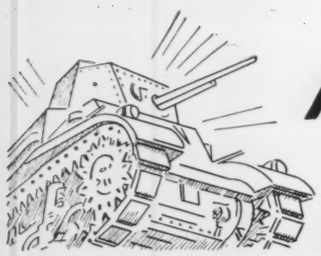
10. Maintenance greatly reduced.
11. No special tools required.
12. Off and on with a wrench in 60 seconds.

THE SHEAVE OF TOMORROW IS THE Q-D SHEAVE . . . made available to you TODAY. Write for booklet V-1400-B7 containing complete details, sizes available, and prices.

**WORTHINGTON PUMP AND MACHINERY CORPORATION**
**General Offices: HARRISON, NEW JERSEY**
*District Offices and Representatives in Principal Cities*

MV1-1

**WORTHINGTON**



**NOW**

**Parker-Kalon Quality-Control is a WEAPON for DEFENSE**

***"No Doubtful Screws" Means No Delays – No Weaknesses In Defense Assemblies!***

Defense plants can't afford assembly delays – can't afford to take chances with "doubtful screws" – screws that look all right but some of which fail to work right. That's why Parker-Kalon production is at capacity to supply them. But even so, the unique Parker-Kalon Laboratory still exercises rigid quality-control over every Parker-Kalon Socket Screw! It's extra protection at no extra cost! Parker-Kalon Corporation, 192-200 Varick Street, New York, N. Y.

*Quality-Controlled*

**16-point test and inspection routine covers: Chemical Analysis; Tensile and Torsional Strength; Ductility; Shock Resistance under Tension and Shear; Hardness; Head diameter, height and concentricity; Socket shape, size, depth and centricality; Class 3 Fit Threads; Clean-starting Threads.**

**PARKER-KALON**
*Quality-Controlled*
**SOCKET SCREWS**


able for conveying water, steam, gas, oil, etc., and can be obtained in any length or type of end-connection. The tubing is reinforced by means of metal braids and armor for high pressures.

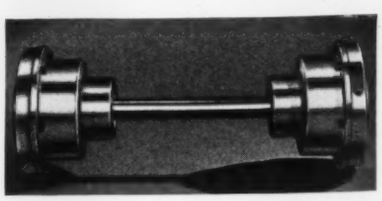
## Clutch Facings Are Improved

ASBESTOS clutch facings produced by Gatke Corp., 228 North LaSalle street, Chicago, have been improved, particularly for automotive service requirements. The facings can be made of different material combinations and various methods of

processing to meet operating conditions. Sizes of the facings are from 14 feet in diameter weighing 1000 pounds and more, to tiny disks weighing less than an ounce. Gear-toothed clutch facings with integrally molded teeth and cone type clutch facings, as well as the conventional disk type, may be obtained in all shapes and sizes.

## Floating Shaft Coupling

ESPECIALLY adaptable for use in paper or steel mill auxiliary applications, a new piloted coupling for floating shafts has been added to the line of Steelflex couplings manufactured by The Falk Corp., Milwaukee. Combining resiliency and shock

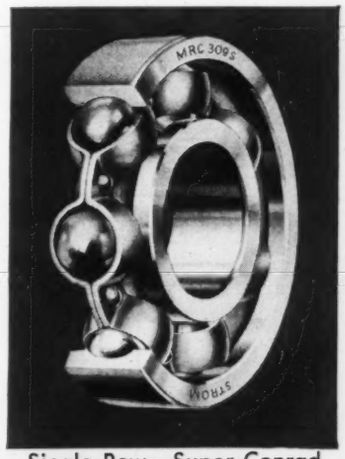


cushioning action with a low angle universal joint action eliminates the necessity for an outboard bearing on extended shafts or auxiliary bearings on intermediate shafts. The coupling also permits flexibility in location of driving and driven units. Constructed entirely of steel the coupling consists of two hubs, one of which carries an integral flange to which the cover is secured, a special tempered steel member forming a complete cylindrical grid

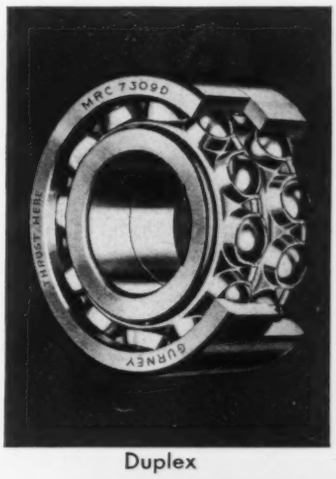
# M-R-C Ball Bearings

ffer a Complete Range of Types and Sizes for Machine Tool equirements—backed by More than 40 years of Experience.

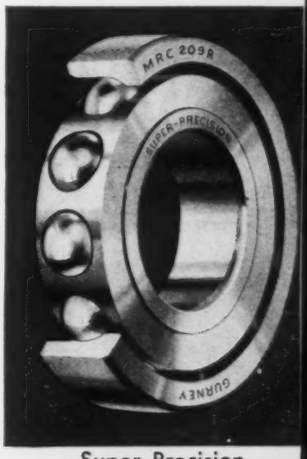
-Row—Max.-Capacity



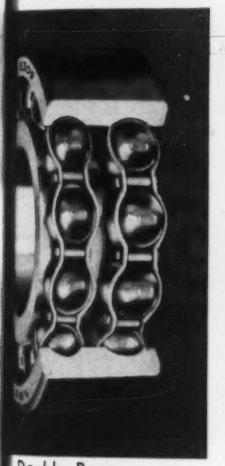

Single-Row—Super-Conrad



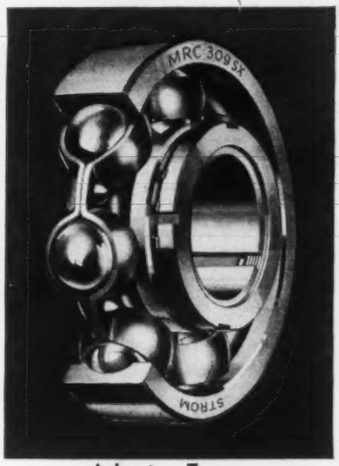

Duplex




Super-Precision

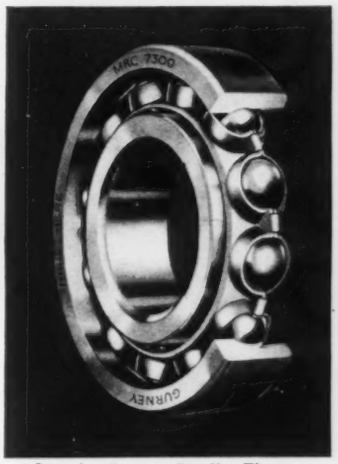


Double-Row

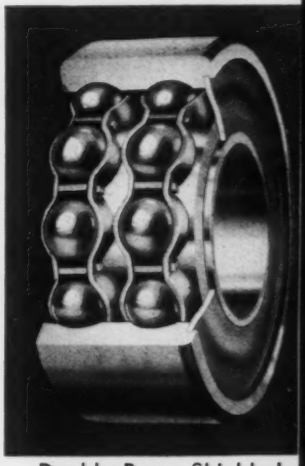



Adapter-Type

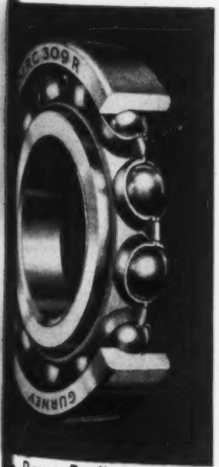
Leadership
M-R-C
Strom
SRB
GURNEY
BALL BEARINGS



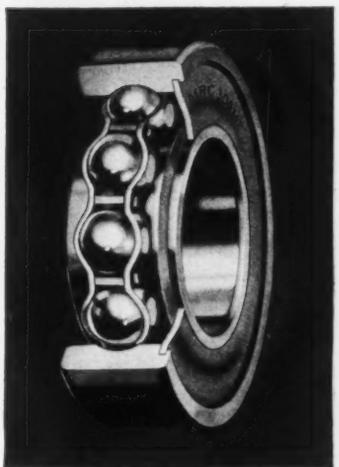

Single-Row—Radio-Thrust



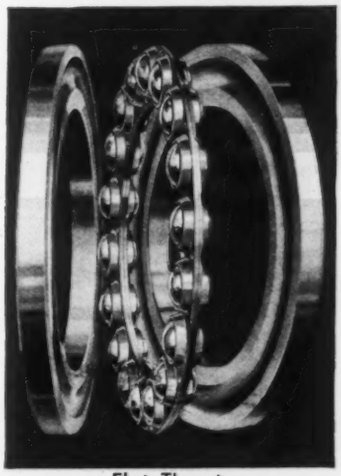
Double-Row—Shielded



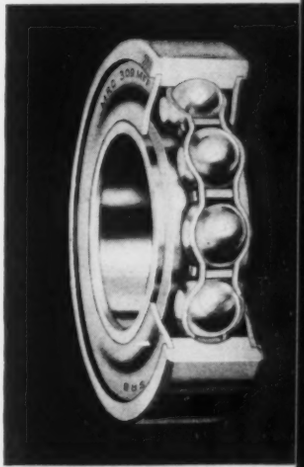

-Row—Radial Type R



Single-Row—Single-Shield



Flat-Thrust



Single-Row—Double-Shiel

# M-R-C Ball Bearings

GURNEY SRB STROM

**MARLIN-ROCKWELL CORPORATION**

*Executive Offices:* JAMESTOWN, N.Y. *Factories at:* JAMESTOWN, N.Y. . . . PLAINVILLE, CONN.

MORE THAN A
Million
OWNERS...
of
Briggs & Stratton Motors Recommend Them For Dependable, Economical, Trouble-Free Performance.
Day after day, year after year — on farms, in homes, and in industry — dependable performance has made Briggs & Stratton motors preferred power wherever gasoline powered equipment is sold.
These motors are recommended too, because Briggs & Stratton motors are backed by a nation-wide organization (identified by the Briggs & Stratton Authorized Service Shield), geared to render quick and efficient service to take care of any emergency.
Briggs & Stratton motors are made to "run," and Briggs & Stratton makes it easy to "keep them running."
Dealers . . .
Briggs & Stratton precision manufacturing of their simple, time-tested, 4-cycle motor design means little or no servicing—usually minor simple adjustments and tune-up that any dealer can perform.
Send for your Free copy of the latest Briggs & Stratton illustrated "Tune-Up" Manual which makes this servicing simple and easy.
AUTHORIZED SERVICE
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Send us, without obligation, Free copy of latest "Tune-Up" Manual.
NAME
COMPANY
ADDRESS
We sell the following machines, powered by Briggs & Stratton motors:

member, and flanged steel cover secured to the hub range with a capsrew.

### High Heat-Resistant V-Belt

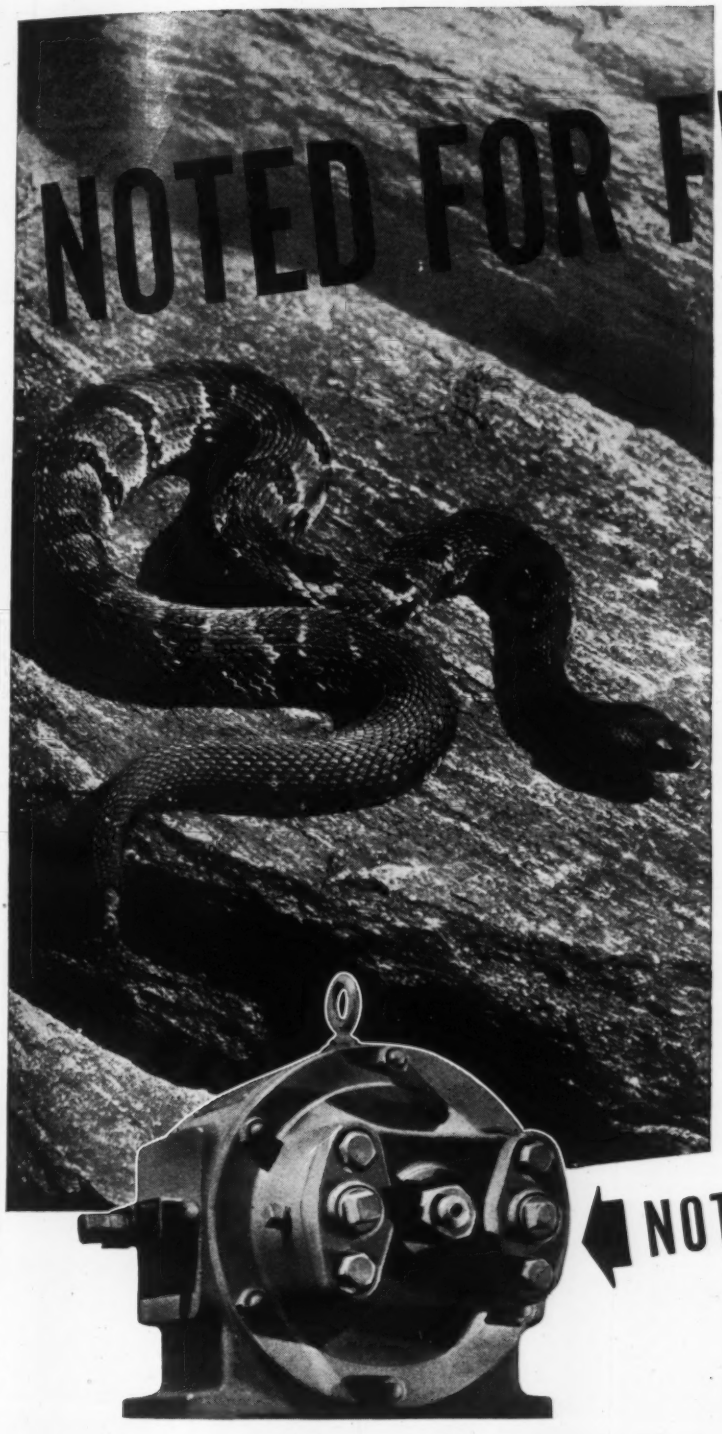
THE B. F. Goodrich Co., Akron, O., has increased the heat-resisting qualities of its standard V-belts so that they are now fully equal to the special black heat-resisting belts, offered by the company. In the past the standard V-belts have been recommended only for operations at temperatures under 130 degrees Fahr., specially compounded heat-resisting V-belts being furnished for higher temperatures. Now that the standard V-belts are available with increased heat-resisting qualities, the special black belt is discontinued.

## Engineering Dept. Equipment

### High-Speed Printing Machine

SYNCHRONIZED to print and develop sensitized materials in one continuous operation, the Model "C" Whiteprint machine, recently placed on the market by the Ozalid Products Division, General Aniline & Film Corp., Johnson City, N. Y., produces prints at speeds up to 12½ feet per minute. The machine can use cut sheets as well as continuous yardage, enabling it to meet peak production demands. Being constructed for either front or

rear delivery, prints are prevented from piling up when production demands are heavy. An automatic device separates the sensitized material from the original, which after printing is delivered to the operator in a receiving tray. The printed material is carried through the developer and deposited into a delivery tray in front, or a sorting table at the rear of the machine, as is desired. A blower removes hot air from the printing cylinder, cools the burner and creates a vacuum necessary for the automatic separating device. Variation of light intensity without changing the printing speed is permitted by an adjustable burner shade. Floor space required for the machine is 19 square feet.



# NOTED FOR FLEXIBILITY

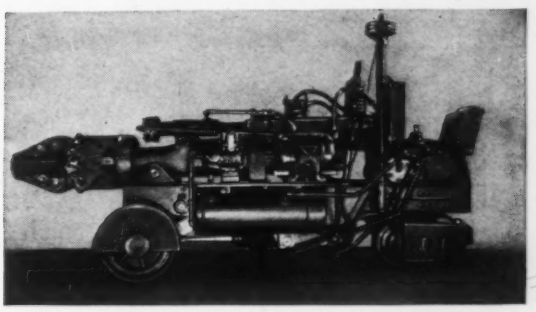
There never was a time when the flexibility in application of Fluid Power, (oil under pressure) meant so much to you. Hele-Shaw Fluid Power is fluid pressure—pressure to operate presses, rams, and reciprocating devices, but how it differs from mechanical drives! Snake-like, it can go anywhere, for Fluid Power is transmitted merely by means of pipes. Obviously this flexibility eliminates the necessity for "designing-in" a Hele-Shaw Fluid Power pump, since you can place the pump wherever it is convenient to do so, on or adjacent to the machine. Free yourself from drive design problems, speed up design with Hele-Shaw Fluid Power. Send for catalog explaining the many other design and operating advantages of Fluid Power today.

## NOTE IT FOR FLEXIBILITY

THE

# Hele-Shaw

**Fluid Power Pump**



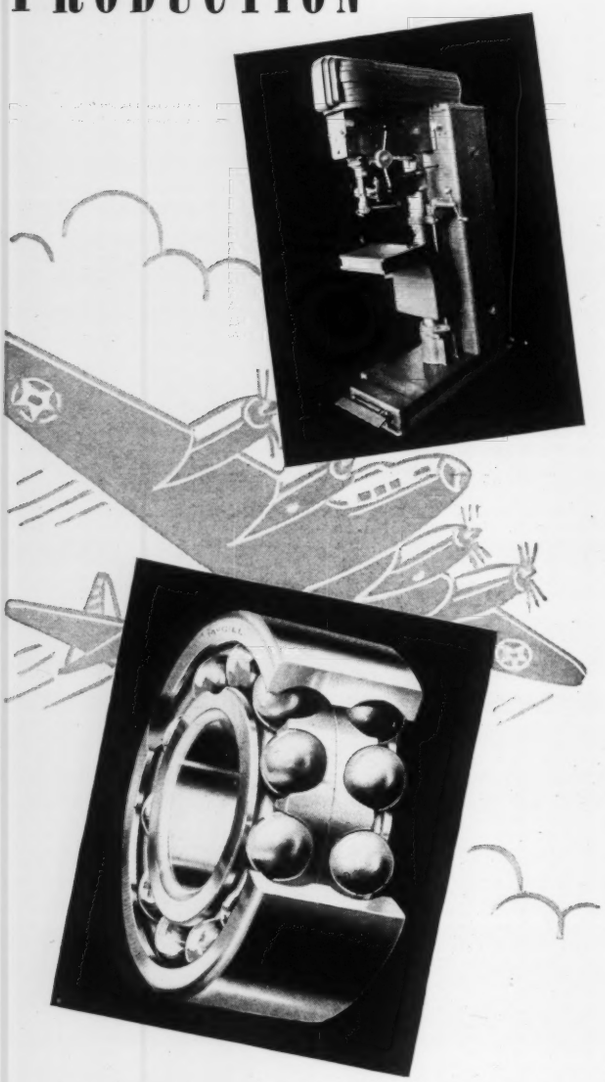
Auto Floor Manipulator, manufactured by Edgar E. Brosius, Inc., Pittsburgh, Pa. The flexibility of Fluid Power makes it possible to locate the Hele-Shaw Pump at a convenient place upon the machine.

*OTHER A-E-CO PRODUCTS:* LO-HED HOISTS, TAYLOR STOKERS, MARINE DECK AUXILIARIES

**AMERICAN ENGINEERING COMPANY**

2502 ARAMINGO AVENUE, PHILADELPHIA, PA.

# SPEED UP . . . PLANE PRODUCTION



## *A Precision Machine Using Precision Bearings*

This No. 2 Bakewell Fast Precision Tapping and Threading machine, made in Los Angeles, is used extensively in airplane plants. It will produce Class 3, Class 4 and U. S. pipe thread gauge fits as routine operations, cutting internal or external, right or left hand as desired.

McGILL Precision Ball Bearings of the Single Row Shielded Series, the Non-Shielded Series, and the Double Row Maximum Capacity Series are built into this machine. There must be a reason . . . it might prove worthwhile for you to get our Bearing Catalog and check up on how you too can use McGILL Bearings to advantage.

McGILL MANUFACTURING COMPANY
*Bearing Division, 1450 N. Lafayette Street*
VALPARAISO, INDIANA

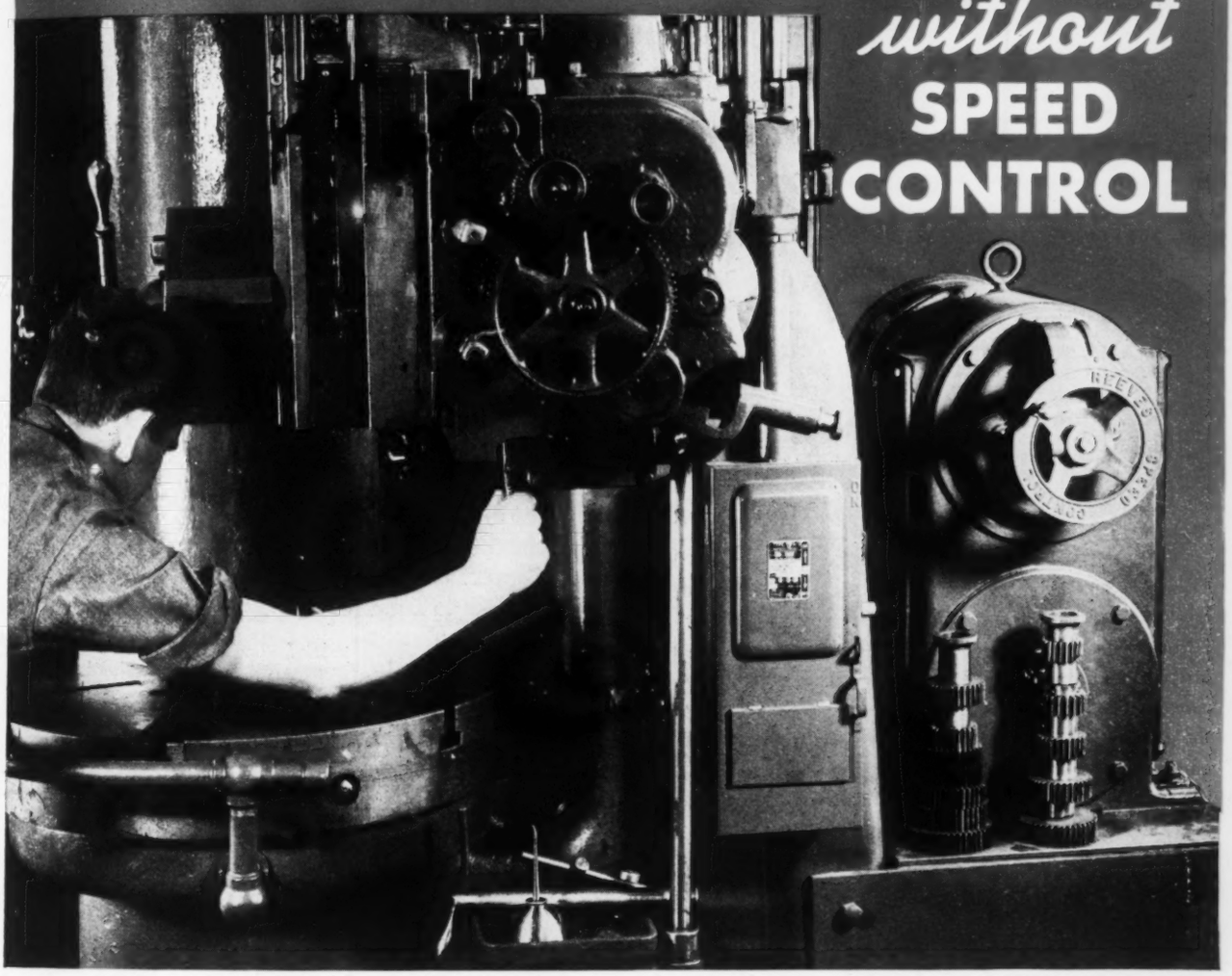

# MEN *Of Machines*

PROMOTION of W. C. Sealey to the position of engineer in charge of transformer design of the Allis-Chalmers transformer division has recently been announced. A graduate of Carnegie Institute of Technology, Mr. Sealey joined the Allis-Chalmers transformer division in 1931 when the company absorbed the American Brown Boveri interests. Prior to 1928 he was connected for several years with the transformer division of Westinghouse Electric & Mfg. Co. During all of this time he has been engaged in design and development work and has a number of patents to his credit. Among other activities he has contributed papers and articles of interest and value to engineering publications on transformers and feeder voltage. Also, he has been identified for some time with the American Institute of Electrical Engineers, and has been active on technical committees of the institute.

* * *

EFFECTIVE recently is the appointment of Charles H. Colvin as director of the Daniel Guggenheim School of Aeronautics, New York University, N. Y. Mr. Colvin was previously acting chief of the instruments division of the U. S. Weather Bureau. After graduating from Stevens Institute of Technology in 1914, Mr. Colvin became associated with the Sperry Gyroscope Co., later the Curtiss Motor & Aeroplane

# IMAGINE DEFENSE PRODUCTION *without* SPEED CONTROL



Never, in the same length of time, could American industry have turned out the thousands of machines of defense, now rolling off production lines, if we were still dependent upon antiquated lineshaft power transmission methods, step-cone pulleys and *fixed machine speeds.* Maximum *acceptable* production with fewest "rejects" comes only when machines are operated at exactly the right speeds—*not too fast, not too slow.*

But increased volume was not the only objective gained by the adoption of individual motorization of machine tools, and *infinitely variable speed control.* Higher quality of output, largely the result of accurate speed adjustability, has made American machines and manufactured products the envy of the entire world.

This company is proud of the part it has played in *pioneering, developing and perfecting variable speed control* units which are accepted throughout American industry as standards of comparison. Our plant is working at high pitch to meet the demands intensified by the present emergency for these units. If you have a machine, or a line of machines which make an essential contribution to our domestic or defense economy, and which can be made more productive with variable speed control, we will equip them for you.

**REEVES PULLEY COMPANY,** *Dept. A,* **COLUMBUS, INDIANA**

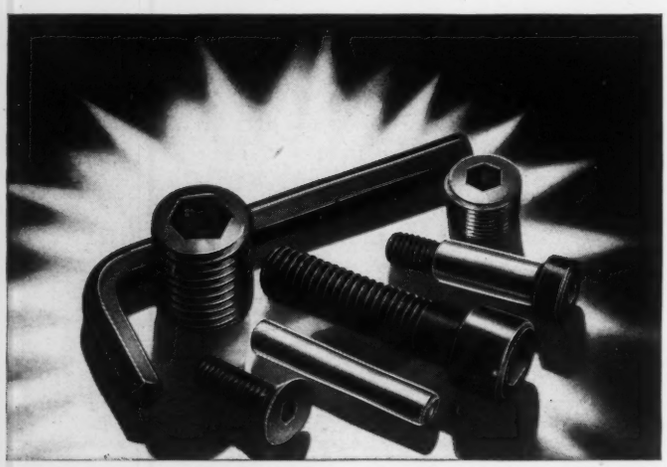
# REEVES *Accurate Variable* SPEED CONTROL

YOU ARE INVITED to meet with Allen Representatives and see the exhibit of Allen Hexagon Hole Products at the Twenty-Third Annual Metal Congress and Exposition. This is not merely a "bid" to visit our Booth, but to talk over mutual interests that we don't get around to discuss personally in our routine dealings. Problems concerning your product and ours, the production and supply situation, Allen's progress in meeting emergency needs, — these have more immediate interest than the usual sightseeing at exhibits. We shall welcome you at Booth B-39 and try to make your stop-in more than usually worthwhile.

★ ★ ★

ALLEN Products are sold only through the Mill Supply Distributor. Throughout the 31 years of our experience, this system has proved the most efficient, economical and satisfactory for customer and supplier . . . Your local Allen Distributor will accommodate you to the limit of his capacity and available supplies.

THE ALLEN MANUFACTURING COMPANY
HARTFORD, CONN., U. S. A.




Co., and has also served as consultant for various American and European aircraft instrument companies. In 1933 he was made head of the Colvin Laboratories and four years later, general manager of the Kollsman Instrument Co. He held this position until last year when he assumed his connection in Washington. Mr. Colvin is also the founder of the Pioneer Instrument Company, of which he was president and general manager from 1919 to 1931. He comes to the college with an outstanding reputation in the aircraft field for technical and administrative ability.

♦

ANDREW HUTTON, recently chief engineer, Davis Engineering Corp., Elizabeth, N. J., has joined Robins Conveying Belt Co., Passaic, N. J.

♦

R. A. FINNEGAN has been appointed chief draftsman of the B. F. Sturtevant Co. Inc., Hyde Park, Boston, with which he has been associated since 1922. He succeeds A. L. FERRANDI, who recently passed away.

♦

DR. ARTHUR S. ADAMS has been made assistant dean of the College of Engineering at Cornell university. Dr. Adams came to Cornell a year ago from the Colorado School of Mines, where he was assistant to the president, as one of a group of three assistants to Dean Hollister.

♦

GORDON ISRAEL, co-designer of the Howard plane, has been named vice president of engineering for Howard Aircraft.

♦

ARTHUR WALSH, executive vice president of Thomas A. Edison Inc., West Orange, N. J., will succeed CHARLES SUMNER WILLIAMS in his duties as chairman of the board.

♦

ROGER SUTTON has been appointed director of engineering and metallurgy for General Alloys Co., Boston. A graduate of the University of Detroit, Mr. Sutton was previously employed by Chrysler Corp., in charge of shop development work and also as an instructor in chemistry and metallurgy at the Chrysler Institute of Engineering.

♦

LAURENCE M. EWELL has been appointed general manager of the Link-Belt Company's eastern division operations, with headquarters in Philadelphia. Mr. Ewell is a graduate of the company's engineering department. He became connected with the company in 1906.

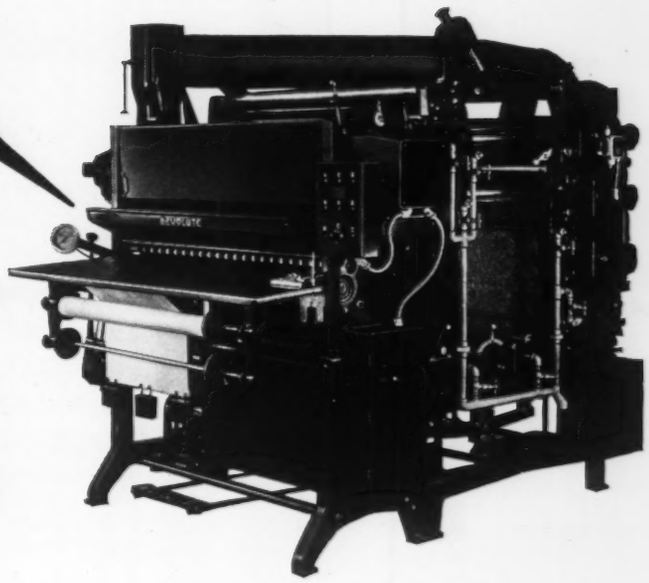
♦

WILLIAM W. COFFEEN, until recently instructor in ceramic engineering, Georgia School of Technology, has been made research associate for the Porcelain Enamel institute at the National Bureau of Standards.

♦

FERNALD S. STICKNEY, formerly instrument designer with Westinghouse Electric & Mfg. Co., Newark, N. J., has been appointed vice president and chief engineer, Instrument Specialties Co. Inc., Little Falls, N. J.

# POWER FOR DEFENSE



## PARAGON-REVOLUTE USERS HELP RELEASE TEN THOUSAND HORSE-POWER PER HOUR FOR OTHER USES

Paragon-Revolute Blue Printing Equipment produces twice the number of prints with the same power as machines using only one side of the arcs. A Revolute, with its revolving glass cylinder that carries tracing and blue print around the light, uses all of the light from both sides of the arc lamps. Users double their output of blue prints.

Lower current consumption also makes possible increased blue print production without necessitating an increase in power line sizes, a change that sometimes costs more than the cost of Paragon-Revolute equipment.

Ask us how you can increase your output without increasing power load.

REQUIRES LESS ATTENTION

SAVES CURRENT

PROTECTS TRACINGS

SAVES TIME

BETTER BLUE PRINTS

### REVOLUTE BLUE PRINTING EQUIPMENT

A Revolute is easy to feed. Tracings ride in on the paper, require no tucking-in—are returned automatically after printing. Static is eliminated. Complete control at front of machine.

Total light utilization (using light from both sides of the arc lamps) doubles printing speed per unit of electricity and permits operation at speeds economically adjusted to operators' ability.

Revolving PYREX Glass Cylinder of Revolute permits tracings to "ride" through instead of "slide." Wear and smudging of tracings is eliminated. No chalking is necessary.

Six low-temperature drying rollers insure rapid, uniform drying that keeps pace with high speed printing. Utilizes heat from arc lamps, saving up to 4 kilowatts.

These features combined with even development and washing are but a part of the efficiency cycle of Revolute Coordinated Blue Printing Equipment that gives you better blue prints, faster and at less cost.

*Write for Complete Catalog*

## PARAGON-REVOLUTE CORPORATION

ROCHESTER, N. Y.

REVOLUTE SIMPLIFIED FEEDING

REVOLUTE TOTAL LIGHT UTILIZATION

REVOLUTE REVOLVING CONTACT

REVOLUTE TEMPERATURE CONTROL

REVOLUTE COORDINATED BLUE PRINTING EQUIPMENT

# WANTED

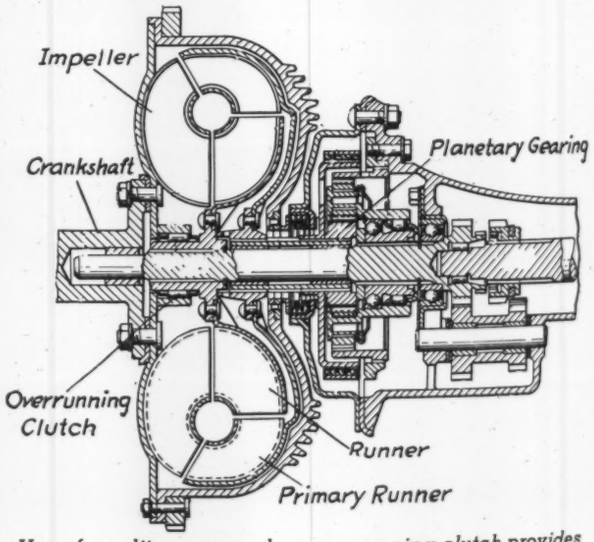
● Mechanical engineer with design or development experience who is interested in editorial work. Position affords excellent opportunity for keeping abreast of advances in the engineering field. Age about 28. Salary open. Address Box 141, MACHINE DESIGN, Penton Bldg., Cleveland, Ohio.


# Noteworthy PATENTS

## Coupling Difficulties Overcome

CERTAIN objectionable characteristics of the fluid coupling drive as applied to automobiles result from the absence of a positive couple between the engine and the driving wheels. The possibility of stalling of the engine while coasting, the impossibility of holding the car on inclines by engaging the gears while the engine is dead, inability to use the engine as a brake and low wheel torque output at low car speeds with the transmission in high gear are some such difficulties.

In a patent assigned to the Chrysler Corp., an overrunning clutch interposed between the impeller and runner of the coupling and the addition of a primary runner to the coupling assembly overcomes these objections. The overrunning clutch is installed in such a manner that the engine is permitted to overrun the driven shaft, thereby passing the drive through the fluid coupling. Since the




*Use of a split runner and an overrunning clutch provides high torque at low speeds and prevents wheels from overtaking the engine*

driven shaft is restrained from overrunning the crankshaft, the engine cannot stall while the wheels are turning; the engine can be used as a brake and can also hold the car on inclines when dead.

To obtain increased torque at low car speeds, the runner is divided into two segments, the runner proper, and a primary runner. This latter is

# BANISH GHOSTS
## WITH THIS NEW TRACING CLOTH

PHOENIX is the new kind of tracing cloth, proofed against perspiration stains and water marks —*that holds erasure scars at a minimum.* PHOENIX gives you clean tracings, in pencil or ink, free from untidy "ghosts" that reproduce on blueprints!

An exclusive new process is responsible for this amazing performance, a process which defies moisture, and gives PHOENIX its unusually durable working surface. You use harder pencils . . . get sharper lines with less tendency to smudge. Even 6H pencil lines show clearly, and reproduce strongly. You don't mar the surface when you erase; erased areas take pencil smoothly —and ink without feathering. Its new white color and its increased transparency provide excellent drawing contrast . . . produce strong blueprints.

Give PHOENIX your own drawing board test. See your K&E dealer, or write for a generous working sample and an illustrated brochure.

**PHOENIX DEFIES MOISTURE GHOSTS**

Perspiration and water splashes on ordinary tracing cloth create "ghosts" which reproduce on blueprints. PHOENIX Tracing Cloth withstands actual immersion in water for fully 10 minutes at a time! *Perspiration and water marks will not stain it!*

**PHOENIX LESSENS SMUDGE GHOSTS**

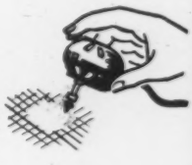
The new improved surface of PHOENIX Tracing Cloth permits you to use harder pencils (5H and 6H) and to get sharper lines with less tendency to smudge.

Result: Cleaner tracings and blueprints.

**PHOENIX REDUCES ERASURE GHOSTS**

Ordinary tracing cloths become scarred when erased... erased spots produce ghosts on blueprints.

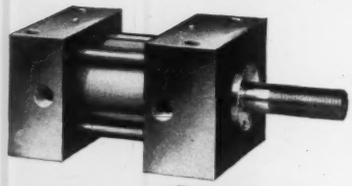
PHOENIX has a durable drawing surface that reduces working scars to a minimum.



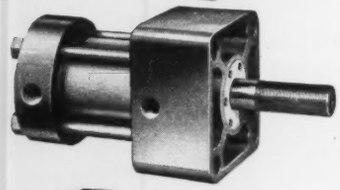
**K&E Phoenix**
REG. U.S. PAT. OFF.
**TRACING CLOTH**
for pencil *and* ink

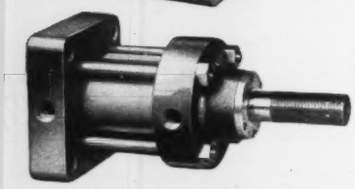
EST. 1867
**KEUFFEL & ESSER CO.**
NEW YORK · HOBOKEN, N. J.
CHICAGO · ST. LOUIS · SAN FRANCISCO · LOS ANGELES · DETROIT · MONTREAL

# POWER MOVEMENT
*applied*
# CONVENIENTLY
*and* # SIMPLY

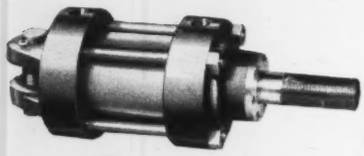


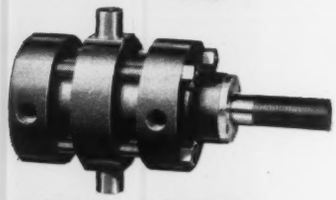
In a direction parallel with the mounting which may be vertical, horizontal or on any angle.



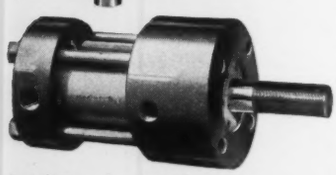


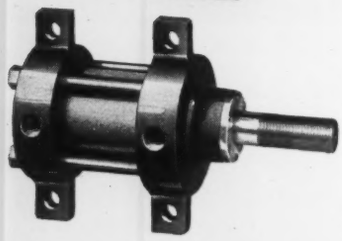
Perpendicularly from the mounting either from the piston rod end or the blank end.





From an end swivel point or from intermediary swivel points.





Perpendicularly from a piloted mounting or from between supports.

*all in cushioned or in non-cushioned types.*

● It will aid in more prompt deliveries, if these standard designs are used. These can be furnished with the least amount of personal attention, requiring no delaying special material requisitions or manufacturing provisions that are necessary for special designs.

Hydraulic Cylinders are shown. These are described in our Catalog H-40. Similar designs are available for compressed air use.

**THE TOMKINS-JOHNSON CO.**

**618 North Mechanic Street** **Jackson, Michigan**


mounted on a quill shaft and drives the sun gear of a planetary speed reduction system the driven member of which provides the drive through the transmission. While the primary runner is thus operative, the main runner rotates at the same or greater speed as the primary. As the main runner approaches engine speed, it takes up the load from the primary runner by means of a second overrunning clutch mounted between the two runner quills to the right of the planetary gear system.

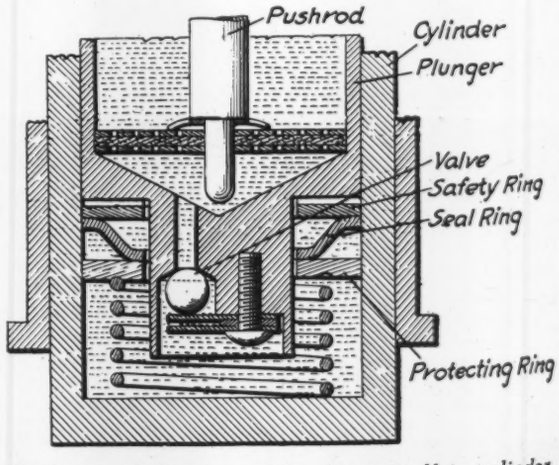
## Ring Design Reduces Leakage

ELIMINATION of foreign matter and compensation for looseness resulting from wear or thermal expansion is essential in preventing leakage in compensators for gas engine valve tappets, working parts of jacks, etc. In a patent assigned to the Eaton Manufacturing Co., these aims are accomplished by providing a seal ring of a ductile material which, under the influence of a spring and fluid pressure, effectively seals against leakage.

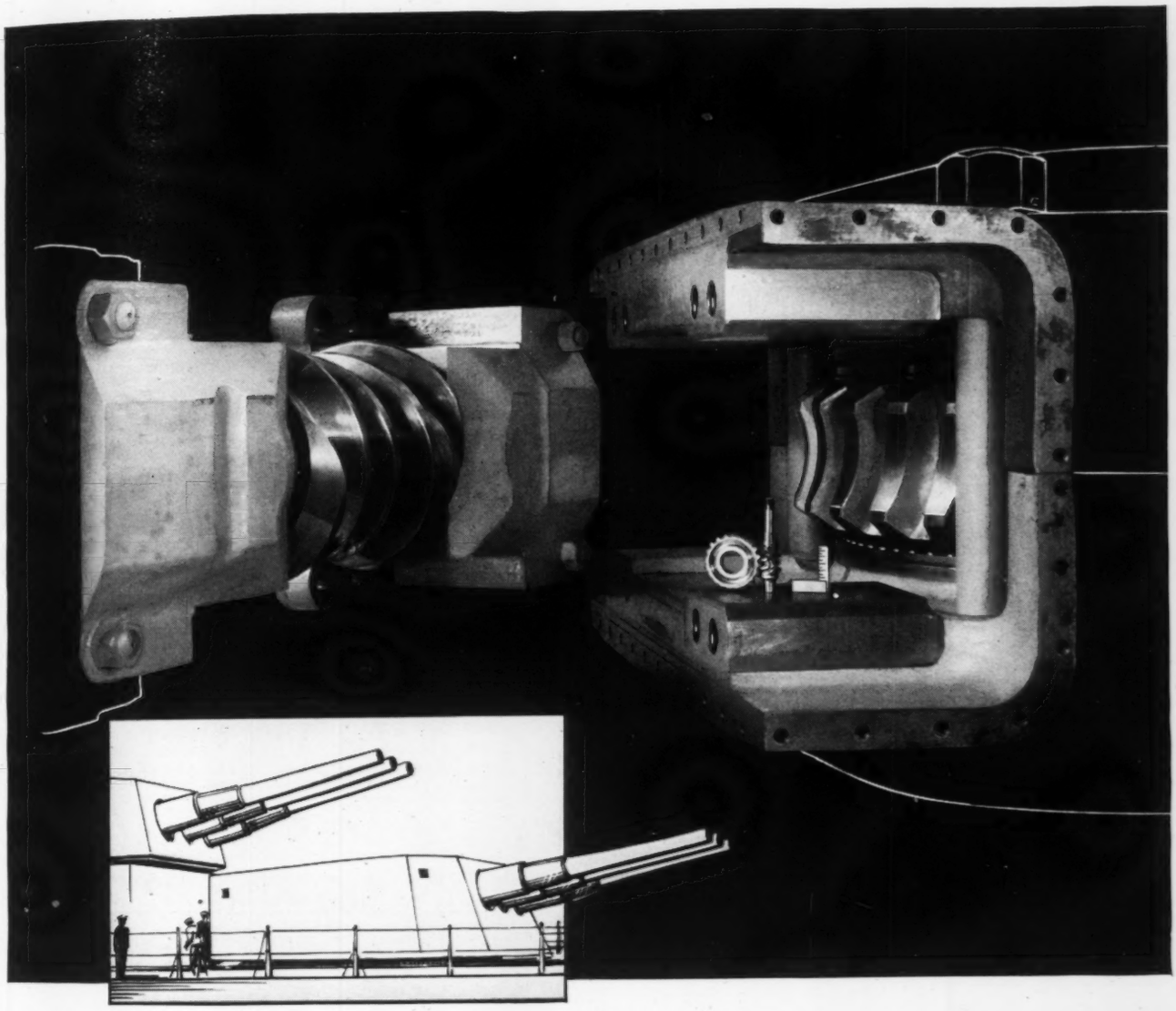
In this invention, close machining tolerances are not required. A plunger is made to fit freely in a hydraulic cylinder. The pushrod, extending down through the upper reservoir, is resiliently mounted in a filter which removes foreign particles from the fluid entering the compensating system.

Bearing on a shoulder formed on the underside of the plunger are the three elements of the clearance compensating means. This consists of ring of S-shaped cross section mounted between a safety ring and a protecting ring. A compression spring maintains a thrust against the protecting ring, holding the assembly against the plunger shoulder.

Load exerted on the system by the pushrod is resisted by the spring as well as by the trapped hydraulic fluid. The seal ring, in consequence of the spring thrust, tends to flatten, exerting a uniform radial thrust against the cylinder wall. By this device, leakage is so effectively reduced that, in order to prevent locking of the system, small radial grooves are formed in the safety ring to by-




*Seal ring of ductile metal adapts itself to cylinder wall, practically eliminating leakage*



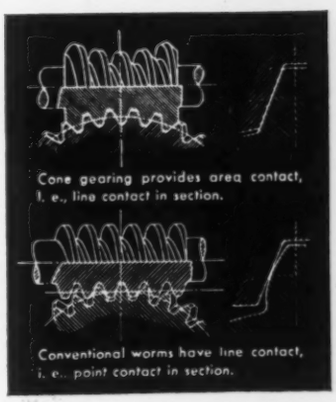
# The Navy Sharpens Its Teeth

TEETH of our new two-ocean Navy are its big guns. On its new battle-wagons—the U. S. S. North Carolina, the U. S. S. Washington, and many more to come—the big guns can "bite" more accurately, than those of any other fleet.

We are proud that Cone-Drive gearing is helping to sharpen the Navy's teeth—that the greater accuracy with which this gearing can be made is so helpful in assuring training accuracy of gun turrets—and that Cone-Drive's vastly greater load carrying capacity (and reduced wear) means a continuous maintenance of that accuracy.

Above is just a glimpse inside one of these giant turrets. Note the size of the gear compared with another —used in an airplane landing mechanism. Yet those big gears are made to *zero* backlash!

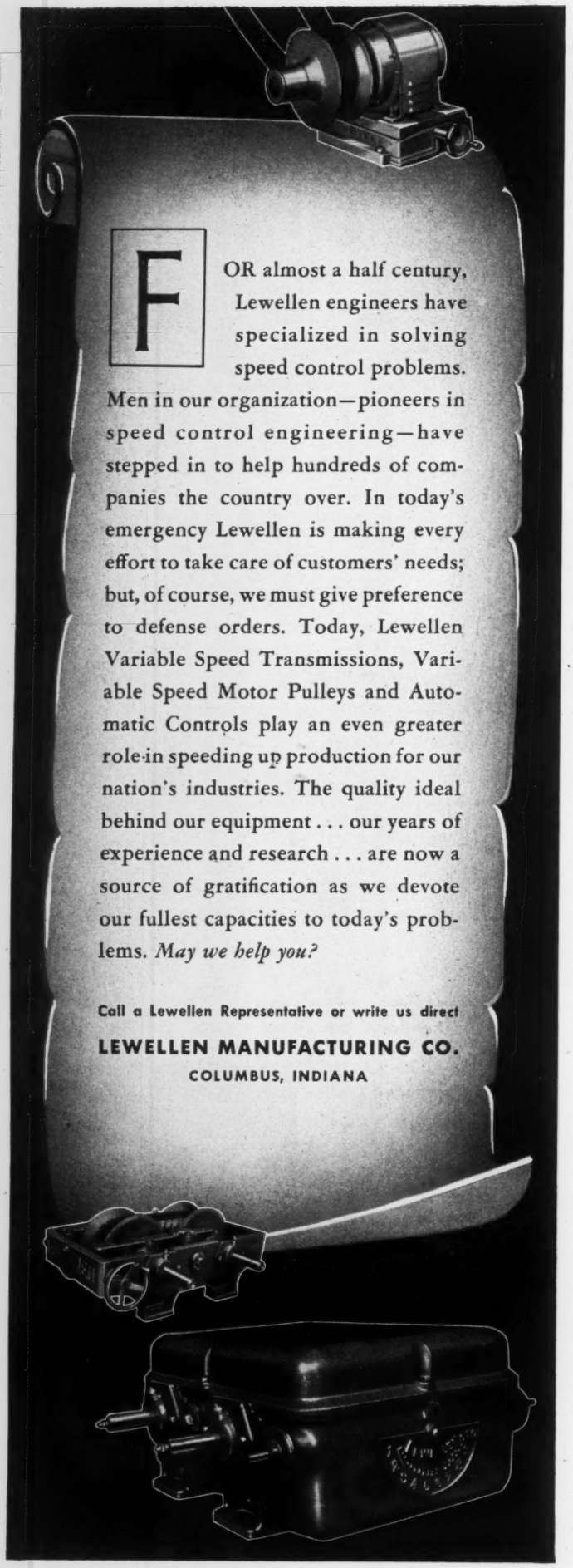
If perchance you do not know the story of this radically new form of gearing, we will be glad to tell you about it. Send for Bulletin CW-41.


Cone gearing provides area contact, i. e., line contact in section.
Conventional worms have line contact, i. e., point contact in section.

**CURRENT CONE OPERATING RANGES**
**Ratios . . Low, 1 to 6; High, 180 to 1.**
**Speed, Low 1/15 rpm., High 30000 rpm.**
**Sizes (C.D.) Low, 5/8 in.; High, 27 1/2 in.**

## CONE-DRIVE DIVISION

**MICHIGAN TOOL COMPANY**
**7171 E. McNICHOLS ROAD, DETROIT, U. S. A.**


FOR almost a half century, Lewellen engineers have specialized in solving speed control problems. Men in our organization—pioneers in speed control engineering—have stepped in to help hundreds of companies the country over. In today's emergency Lewellen is making every effort to take care of customers' needs; but, of course, we must give preference to defense orders. Today, Lewellen Variable Speed Transmissions, Variable Speed Motor Pulleys and Automatic Controls play an even greater role in speeding up production for our nation's industries. The quality ideal behind our equipment . . . our years of experience and research . . . are now a source of gratification as we devote our fullest capacities to today's problems. May we help you?
Call a Lewellen Representative or write us direct
LEWELLEN MANUFACTURING CO.
COLUMBUS, INDIANA


pass a predetermined amount of fluid under normal loads.

## Pump Valves Synchronized

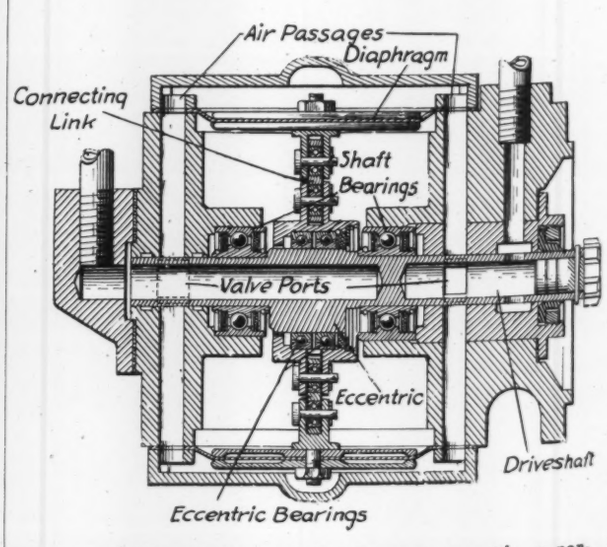
AIRCRAFT instruments which are driven by positive or negative air pressure must be protected from dust or other foreign matter that might enter through the operating air. Circuits which operate by drawing air from the atmosphere and pumping it through the instrument are ordinarily protected by some sort of filter.

Such filters may clog, increasing pressure drop, and their efficiency only approaches perfection. Assigned to Sperry Gyroscope Co., a patent discloses a pump for a closed-air system which obviates the need for filters, recirculating the same air through the system.

Four diaphragms are arranged radially at 90-degree intervals around a driveshaft, each being driven from a common eccentric integral with the shaft. Bearings for the shaft, eccentric and connecting links are of the antifriction type. The shaft itself is drilled out from each end, leaving a partition separating the ends of the two drillings. Ports cut through the walls of the resulting hollow shaft register with air passages.

The left end of the shaft constitutes the discharge passage; the right end is closed by a splined plug which also forms the male section of the driving coupling. Inside the packing gland, the inlet air drilling has access to the interior of the shaft.

As the shaft is rotated the diaphragms are reciprocated in substantially harmonic motion, producing the pumping action. Also, as the shaft rotates, the valve ports progressively uncover the air passages. Smooth performance of the pump and absence of "pounding" is attributable to this valve action. Since the ports rotate harmonically at the same frequency as the diaphragms, the valve opening at any instant is substantially proportional to the rate of diaphragm displacement.




*Four radially positioned diaphragms provide a non-pulsating flow for closed pneumatic circuit*

# Selecting Special Motors

WHAT must I know about motors? . . . What are their advantages and disadvantages? . . . What type should I use? These and many more problems relative to specification and use of special motors are discussed by recognized authorities in the 48-page booklet, "Selecting Special Motors".

Originally printed serially in MACHINE DESIGN, these nine articles have been reprinted in a convenient form so that the facts of special motor selection will be immediately available within a single cover.

**CONTENTS**

Part I —Mountings and Enclosures, by C. W. Drake

Part II —Small Reversing Motors, by W. M. Yogerst and C. A. Rall

Part III —Lightweight D. C. Motors, by W. H. Fromm

Part IV —Multispeed Induction Motors, by J. H. Fortenbach

Part V —Frequent Starting and Reversing Motors, by R. J. Owen and J. J. Kirkish

Part VI —Short Time Rated Motors, by G. R. Anderson

Part VII —Torque and High Slip Motors, by W. R. Hough

Part VIII—Small Built-in Motors, by J. H. Staak

Part IX —Adjustable Speed Motors, by H. M. Edmunds

*Price: Fifty Cents Postpaid*

# MACHINE DESIGN

PENTON BUILDING CLEVELAND, OHIO

★

## ACKNOWLEDGMENT

★

MACHINE DESIGN takes this opportunity of thanking all those companies and individuals who co-operated in the compilation of the accompanying Directory of Materials, stitched into the center of this October issue. We are particularly indebted to the manufacturers of the materials for their response to requests for information on their products, and to the advertisers whose collaboration made possible the presentation.

★

# Influence of Vanadium on Design Materials

(*Continued from Page* 53)

tions. Not only have some of the steels, such as manganese vanadium, shown unusual weldability in the form of plates, tubes and other structural shapes requiring no subsequent stress relief, but welding rods of carbon vanadium and chromium vanadium steels for gas or electric welding also produce characteristic fine-grained deposits, tough and wear resistant. In built-up rail ends, for example, the deposits having a brinell hardness of about 300 as laid down, cold-work harden to about 440 in service.

Whether a specific steel is able to meet all the requirements of fabrication and service in springs is largely a matter of experience rather than prediction. Not that mechanical tests are unimportant, but to be a successful spring steel a material must meet an exceptionally long series of requirements—from good melting practice, uniform response to heat treatment, and finishing, to sustained mechanical properties after long service under heat, cold, sudden impact, surface damage. How a given steel will stand up under all these conditions, resisting failure by breakage or settling, is established largely by experience.

### Silicon Vanadium Used for Springs

Vanadium steels have, however, long been recognized as an ideal material for springs. In general, SAE 6150 chromium vanadium spring steel is employed for small and medium sized applications made from flat or round bars or from flat or square wire. To insure, in larger sections, the same strength properties under a given heat treatment as can be secured from SAE 6150 in one-half inch diameter, higher carbon, manganese and chromium contents are used.

Silicon vanadium springs perform well in such heavy applications as railroad service. This steel possesses an especially good surface condition; minor surface imperfections common to all steels are removed during hot-working at the mill.

For higher temperature applications such as internal combustion engines and steam valves, vanadium steels with tungsten and molybdenum provide high creep resistance.

### Grain Size Is More Uniform

Steel castings containing vanadium have a higher elastic ratio than castings without vanadium but of otherwise like composition and heat treatment. At the same time, the vanadium castings possess at least equal ductility in tension and a considerably higher impact strength and wear resistance. Grain size is smaller and more uni-

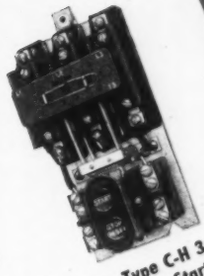
# New C-H Manual Starter WITH PUSHBUTTON OPERATION

## (NEMA Size 1 for A. C. Motors from 1½ to 7½ h. p.)

Now Cutler-Hammer announces a new Size 1 Bulletin 9115 Manual Starter with PUSHBUTTON operation. This is an entirely new model . . . has the famous C-H Eutectic Alloy Overload Protection, interchangeability of parts with C-H Size 1 Magnetic Starters, and many other positive advantages. Note the compactness of this starter, its modern styling and appearance, its convenience of wiring.

The 3-pole pushbutton starter is priced at only $9.50; other sizes in proportion.

Write at once for further details. CUTLER-HAMMER, Inc., 1310 St. Paul Ave., Milwaukee, Wis. Associate: Canadian Cutler-Hammer, Ltd., Toronto.



**Skeleton Type C-H 3 Pole Pushbutton Starter**

C-H Skeleton Starters solve many costly "built-in" control problems for busy machinery manufacturers. They offer the same modern construction and features as the enclosed starter shown above.

### These new features tell the whole story

**1.** New heavy "fine" silver, movable and stationary contacts. Easy to reach for inspection and replacement (interchangeable with contacts on size 1, C-H 9586 Automatic Starters).

**2.** New clamp type pressure connectors on line terminals.

**3.** New easy operating, quick break pushbutton mechanism.

**4.** New rubber mounted panel with effective grounding clip.

Loosen but one screw to remove panel.

**5.** New enclosing case; light interior, exceptionally large wiring space, plenty of knockouts.

**6.** Heater coils interchangeable with size 0, C-H 9115; sizes 0, 1, 2, C-H 9586 and many other standard C-H starters.

**7.** Available in 2, 3, or 4 pole construction.

*Dust Safe* VERTICAL *Contacts*

CUTLER-HAMMER
MOTOR CONTROL
C-H

INTERIOR VIEW OF TUTHILL PLANT
OPERATING 24 HOURS A DAY TO SERVE INDUSTRY

*Dependability*

**WAS NOT BUILT OVERNIGHT . . .**

The dependability of Tuthill pumps was no overnight development. It has taken almost 20 years of research, endless testing, steadily expanding plant facilities and applied experience to realize the high standards of Tuthill internal gear rotary pump performance.

With a background like this, you can depend on Tuthill pumps to meet your requirements. Write for catalog today.

PUMPS FOR
LUBRICATION
COOLANT HYDRAULIC
OIL BURNERS STOKERS
LIQUID TRANSFER
¼ to 200 g.p.m.
0 to 350 p.s.i.

**TUTHILL PUMPS**

TUTHILL PUMP COMPANY, 941 EAST 95th ST., CHICAGO, ILLINOIS

**ARE YOU BAFFLED BY A SEALING PROBLEM . . ?**

★ If you are faced with a perplexing seal job, Acme Industrial Company offers the aid of trained engineers who specialize in solving the most involved sealing problems.

Your product may include rotating seals that must retain fluids and gases. These, of course, must be properly sealed, not only to prevent costly leakage, but to forbid entrance of foreign particles.

Acme does exactly that . . . and more. The Acme method of lapping the surfaces, provides seals that are initially tight . . . that stay tight indefinitely. Their strict uniformity cuts original assembly expense and practically eliminates re-assembly and re-testing costs.

**Move Your Lapping to the Acme Plant!**

Conserve space. Release skilled help for other important duties. Transfer your lapping and sealing jobs to the Acme plant. Your blueprint or complete seal in our hands will bring back valuable suggestions . . . will convince you that Acme service can form a lasting allegiance between your engineering and production departments and ours. Write.

ACME ADVICE IS YOURS FOR THE ASKING

**ACME INDUSTRIAL CO.**

*Makers of Standardized Jig and Fixture Bushings*
211 N. Laflin St. MONroe 4122 Chicago, Ill.

form, while grain growth at heat treatment temperatures is retarded.

Other components of composition being alike and the details of steelmaking such as melting and pouring being practically constant, a vanadium steel will exhibit less marked dendritic segregation and greater freedom from Widmanstatten patterns within the grains. This is recognized as an extremely important factor in the manufacture of many intricate castings where cracking during heating and cooling cycles is eliminated. The effect is to simplify heat treatment and produce more uniformity in final structure. This means greater ability to sustain stress or to deform rather than rupture under sudden overloads.

### Increases Impact Resistance

Mechanical properties may be obtained by double normalizing and tempering that are not equalled even by more drastic and often dangerous liquid quenching and tempering of many other alloy steels. This is of great importance in large complex castings. In fact, suitable adjustment of composition, combined with single normalizing and tempering or sometimes single normalizing alone, open up new possibilities in the use of high-strength cast steels.

Simultaneous increase in both yield point and resistance to impact results from the incorporation of vanadium, without appreciably altering the tensile strength, elongation or reduction of area. Ability to support high static loads and suddenly applied overloads without rupture has been responsible for numerous engineering applications. Some idea of the range of application is indicated by Table IV.

On the other hand, cast steels without vanadium, when compositions or heat treatment or both are adjusted to produce high hardness and tensile strength, generally show a rapid decrease in impact value. Engineers are taking increasing cognizance of this fact and the benefits of vanadium upon impact strength of cast steels, even when applied to types of service where high impact value affords a great measure of insurance against failure. It will not be surprising, therefore, to see an even wider application of vanadium to these fields in the future.

The extensive use of vanadium in tool steels is well known. It can be said that vanadium has been applied to practically every high grade type of tool, including all kinds of cutting tools, dies subjected to severe stress or impact, and precision instruments of many kinds. In all high-speed tool steels, vanadium is, of course, one of the essential elements, contributing stability at high temperatures, toughness, resistance to impact and hot hardness.

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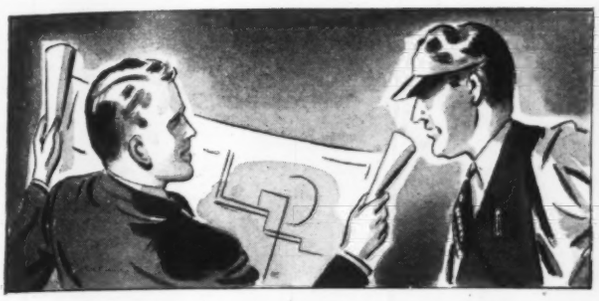
CORRECTION—In the article, "Avoiding Excessive Deflection in Yoke Design" on Page 66 of the September issue in formula 3, the denominator of the first term of the second member should read $4\,Ep^3$.

# Then I "pumped" Blake about pumps



1 "'It *looks* O.K.,' said the boss when he saw the blueprint, 'but are you sure you have that pumping problem solved?' Frankly, I wasn't absolutely sure. It was tough, viscous material to pump and the flow had to be uniform without turbulence."

2 "So I decided to make a final check and 'pump' my friend Blake about the pumping problem *he* solved. 'Better investigate that new R & M Moyno,' he said. 'I never saw a pump perform so well and stand up. We haven't spent a dime on it since it was installed.'"

3 "Blake sent me one of his Moyno pump folders, and when I checked all those Moyno features I decided that here was my *right* answer. A pump amazing in simplicity, revolutionary in principle and compact enough to fit my machine design like a glove!"

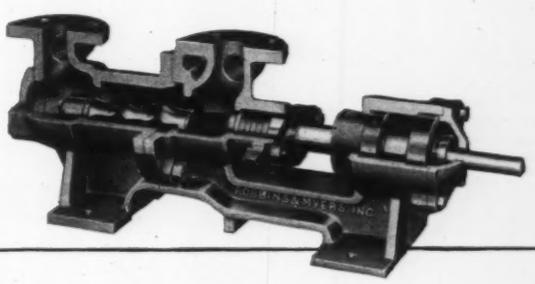
4 "One look at that rotor and stator convinced me that the R & M Moyno was built for *service* and *efficiency*. Yes, sir, that positive displacement and self-priming feature, the elimination of valves, pistons and smooth, even delivery were just made to order for my problem."

YOUR problem may be pumping molten rosin, forcing high-pressure coolant through bars in a boring lathe, handling gritty liquids and alkalis or acids. If it flows through a pipe, you can count on the R & M Moyno pump to handle it . . . with uniform discharge . . . at constant, even pressure.

Here's a pump that is the greatest contribution to the science of pumping in a decade. It has proved itself superior to other conventional pumps in practically every type of application both here and abroad.

The R & M Moyno has all of the advantages of centrifugal, rotary, screw and reciprocating pumps, yet is radically different from any in principle. It has only two working parts, a rotor and stator, which create pumping action like that of a piston moving through a cylinder of infinite length. It operates with minimum wear and maintenance and can be completely dismantled and reassembled in 30 minutes. Standard sizes range in capacity from ½ to 175 gallons a minute, with pressures as high as 1,000 PSI.

Investigate the R & M Moyno for *your* pumping problem. Write today for Folder No. 1777 entitled, "A New Principle in Pumping."



**The R & M MOYNO PUMP**

**ROBBINS & MYERS, Inc.**

MOYNO PUMP DIVISION SPRINGFIELD, OHIO

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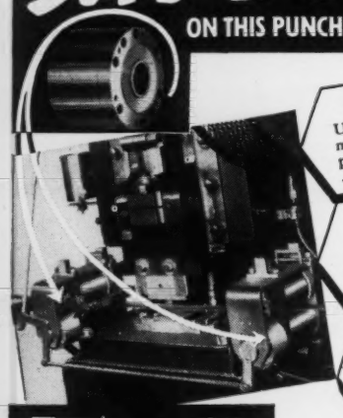
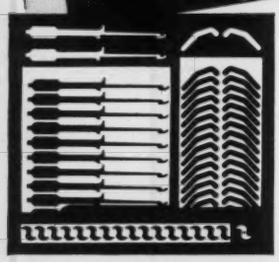
MORSE Indexing CLUTCHES
SAVE 8% IN STOCK
ON THIS PUNCH PRESS DOUBLE ROLL FEED



MORE PUNCHINGS
Uniform indexing control permits closer and more punchings per given stock—less scrappage . . . greater savings!

ACCURATE INDEXING
Greater accuracy permits a higher rate of feed resulting in considerable increased machine production.

25 DIFFERENT PUNCHINGS
Varying speeds and index strokes to accommodate various stocks is accomplished by one machine adjustment.



SUPERIOR RATCHETING METHOD
Morse Indexing Clutches affected an 8% stock saving on above installation. Because of greater indexing accuracy, closer and more uniform punchings were possible, as shown at left. Rate of feed was increased considerably There is a Morse Clutch to meet your requirements—investigate *now*.

*IMPORTANT*—Send for engineering data. It contains helpful ratcheting and indexing information!

MORSE INDEXING AND FREE-WHEELING CLUTCHES
Morse Chain Co., Detroit, Mich. • Ithaca, N. Y. • Div. Borg-Warner Corp.



Be SURE Your
VACUUM PUMPS
Will Take The TOUGHEST PUNISHMENT
*Specify*
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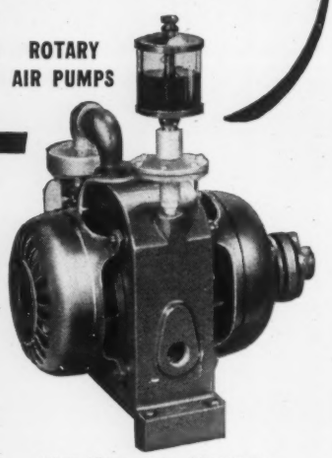

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# Theory of Elasticity in Practical Design

(*Continued from Page* 65)

To simplify the design for contact loading the nomographic charts, *Figs.* 92 and 93, are presented. In constructing *Fig.* 92 the average value of $\lambda$ of .30 was used. Variation in its value, which will run between .25 and .35 for most materials, will introduce a possible error of only $\pm 1.7$ per cent.

In using *Fig.* 92 proceed according to the column numbers. Enter on Column 1 with $E_a/E_b$, the ratio of the elastic moduli, and find, on Column 2, $r_1/r_2$ the ratio of the radii. The intersection of a line connecting these two points with the line of Column 3 gives turning point, *T. P.* 1. On Column 4 locate $E_a$, the smaller modulus. The intersection of the line from this point to turning point *T. P.* 1 with the line of column 5 gives *T. P.* 2. Now locate on Column 6 the value of $P'$, the load per inch of length per inch of smaller roller radius. The intersection of the line from this point to *T. P.* 2 with Column 7 will give $q_0$ and $v_m$; or if $P'$ is desired and $q_0$ or $v_m$ given, Column 7 is first used and then 6. By following in the sequence of column numbers the chart may be quickly and easily used. *Fig.* 93 may now be used to determine the width of contact and the depth to the maximum shear stress. This last is of value for determining case depth.

To illustrate, considering a roller on a plane, both of steel, $E_a/E_b = 1$ and $r_1/r_2 = 0$. The line connecting these two points is shown on *Fig.* 92, as is the line from *T. P.* 1 to $E_a = 29{,}000{,}000$, locating *T. P.* 2. The dotted line from this point to $P' = 700$ locates $q_o = 59{,}700$ and $v_m = 17{,}900$ for this value of the load. The dotted line on *Fig.* 93 connects these values of $P'$ and $q_o$, and shows that $a = .0075r_1$. The maximum shear is at $.0059r_1$.

In the case of a cylinder with a varying radius of curvature, the radius at the point of contact should be used. As before, this radius must be large with regard to $a$.

## Stresses Are Independent of Radii

Presented in *Fig.* 89 is the variation in the three principal stresses as given by Equations 157, 158 and 160, with the distance of the stress point below the surface. Note that all three are a maximum at the top and diminish rapidly with increase in the distance from the surface. In terms of $q_o$, the maximum pressure, they are independent of the roller radii, and $S_x$ and $S_y$ of the elastic constants. $S_z$, however, varies directly with $\lambda$.

Substituting the total load from Equation 161 in 110 gives for the $S_y$ stress from a concentrated load, $S_y = aq_o/y$. This is the dotted curve in *Fig.* 89. It quickly approaches the stress as given by the elliptical distribution and the $S_x$ stress quickly vanishes. This is another substantiation of St. Venant's prin-

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| Size Awg | Heavy Formex | Enamel Single-cotton |
|---|---|---|
| 8 | | 19.7 |
| 9 | 19.7 | 24.9 |
| 10 | 24.9 | 31.3 |
| 11 | 31.4 | 39.4 |
| 12 | 39.5 | 49.6 |
| 13 | 50.0 | 62.5 |
| 14 | 62.9 | 78.8 |
| 15 | 79.4 | 98.9 |
| 16 | 99.0 | 124 |
| 17 | 125 | 156 |
| 18 | 158 | 197 |
| 19 | 199 | 247 |
| 20 | 256 | 310 |
| 21 | 315 | 389 |
| 22 | 398 | 487 |
| 23 | 503 | 611 |
| 24 | 633 | 763 |
| 25 | 794 | 955 |
| 26 | 1000 | 1190 |
| 27 | 1260 | 1490 |
| 28 | 1580 | 1850 |
| 29 | 2000 | 2290 |
| 30 | 2520 | 2850 |
| 31 | 3160 | 3510 |
| 32 | 3990 | 4360 |
| 33 | 5050 | 5300 |
| 34 | 6330 | 6420 |
| 35 | 7940 | 7900 |
| 36 | 10050 | 9410 |
| 37 | 12650 | 11600 |
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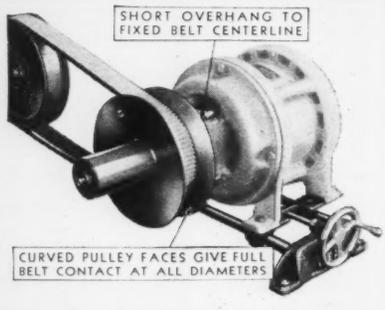


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ciple. It would appear that at distances of about $2\frac{1}{2}a$ or more below the surface the stress will be more closely approximated by the case of concentrated loads on a disk, as given in the August issue, than by the above.

*Fig.* 91 presents the variation in the "$Q$ stress" with distance from the surface. $Q_{xy}$ is given by Equation 159 and $Q_{yz}$ by $S_y - S_z$ which gives

$$Q_{yz} = \frac{(1-2\lambda)a^2+2\lambda y(\sqrt{a^2+y^2}-y)}{a\sqrt{a^2+y^2}}\, q_0 \ldots\ldots (163)$$

$Q_{xz}$, being much less than $Q_{xy}$ or $Q_{yz}$, is not shown.

The terms "subsurface stress" and "contact stress" usually refer to the maximum shear stress. This is equal to one-half the $Q$ stress and therefore the curves of *Fig.* 91 measure this stress. On the basis of the maximum shear theory of failure, which will be discussed in detail in a later article, these stresses are the failure criterion. They are presumed to cause a failure at the distance below the surface at which they are a maximum. A failure of this sort is believed to result in minute pitting of the surface, as illustrated in the photos of S. Way previously mentioned. $Q_{yz}$ is affected by the value of $\lambda$. If $\lambda$ is as low as .25, which would be the case with commercial grades of cast iron, $Q_{yz}$ maximum will nearly equal $Q_{xy}$ maximum. Since no material is known to have a value much less than $\lambda = .25$, it is satisfactory to consider only $Q_{xy}$.

### Stress at End of Roller Is Important

At the ends of the roller the $Q_{yz}$ stress may, however, be of considerable importance. At this point the $S_z$ stress vanishes because of the departure from plane strain (boundary condition). If the $S_y$ stress were maintained this would give $Q_{yz} = -q_0$, or 2/3 greater than $Q_{xy}$ maximum. While the actual stress developed probably will not be this high there is reason to believe that it may exceed $Q_{xy}$. *Fig.* 90 illustrates the failure of a number of large chilled iron rollers supporting a heavy revolving structure. Pieces spalled and flaked off at the end, as indicated in the figure. The addition of the "shrouding" material, shown in section, eliminated the trouble. It is believed that the addition of this material served to establish the condition of plane strain before the load was reached.

What with the number of approximations and the rather involved derivation, one may well entertain a feeling of doubt as to the reliability of the equations just developed. Photoelastic analysis unfortunately is not well adapted to the study of these stresses because of their local nature and because of the uncertainty of the value of the elastic constants of the model material. However, *Fig.* 94 is offered as affording some check. This is a 6-diameter enlargement of the disk shown in *Fig.* 68 of the August issue.

The stress builds up to a maximum of 22 fringes near the surface and then drops away, the mass of detail hiding this portion of the picture. A load of 160 pounds was applied by means of a flat steel plate. $\lambda$ for the Bakelite will be assumed as .35, $E$

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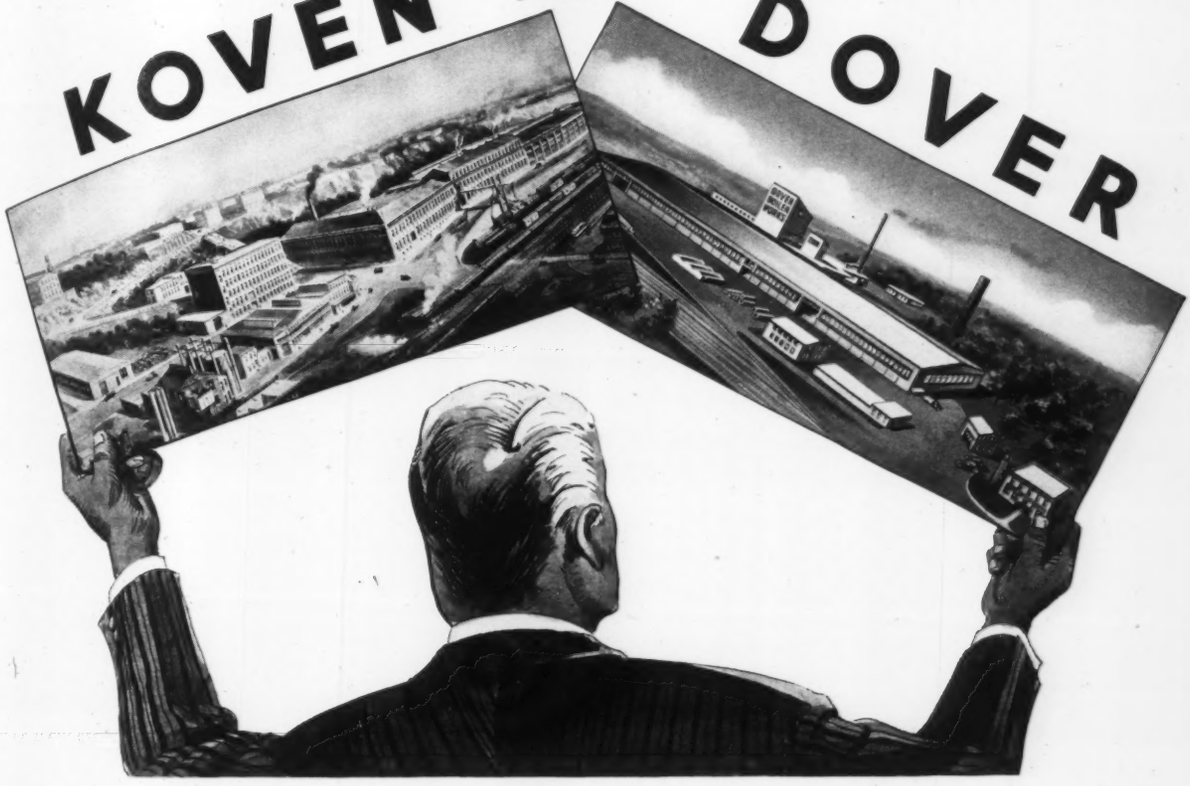

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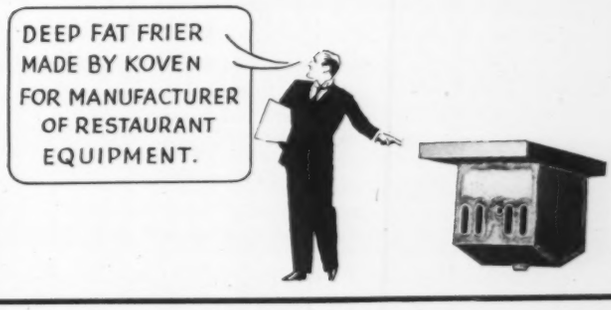

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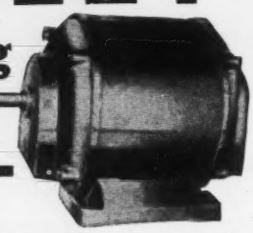

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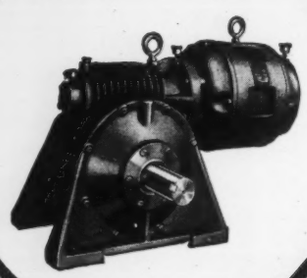

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was determined by a bending deflection test as 593,000. Disk is 1.085-inch diameter by .276-inch thick and $H = 86.6$. Then $q_o$ computes at 15,000 pounds per square inch, $a = .025$-inch. Maximum $Q$ stress is at .019-inch and equals 9020 pounds per square inch. Photoelastic stress $= 22 \times 86.6 \div .276 = 6900$ pounds per square inch or 76 per cent of the calculated stress. Depth measures about ¼ greater than the calculated. Ratio $b/a$ is 11. While this is probably enough to develop plane strain at the center, that condition will be departed from for a considerable portion of the thickness, which will, of course, effect the fringe value. Model is undoubtedly stressed beyond the yield at the surface, and while yielding may not actually have occurred at the center of pressure it probably has at the two ends of the "cylinder."

Same disk in *Fig.* 95 is shown with the steel plate replaced by one of Bakelite. Again the "centers of shear" may be noticed.

Hertz is reported to have made a check on his equations for the area of contact by loading a glass sphere on a flat glass plate, and by loading two crossed glass cylinders. He reported good agreement.

Probably the best tests that have been made were those of Thomas and Hoersch previously referenced. These were made on a roller on a plane to determine the location and value of the failure by exceeding the shear yield. The equations were checked to within a few per cent. However, this was on a flat surface, for which they will be more accurate. Tests were also made on the three-dimensional case of cylinders with crossed axes. These also checked.

### Common Practice Is Usually Satisfactory

It has been common practice to allow a load of 1200 pounds per inch of length per inch of radius on bridge rollers and rockers of mild steel. This would give a $q_o$ of 78,500 pounds per square inch, which would be considerably higher than the yield of that material. The maximum shear stress would only be .3 of this however, or 23,600. While this figure might be slightly above the shear yield, it should be noted that the loading is based on a maximum possible load on the structure, one which is probably seldom, if ever, reached. It would seem that this figure is reasonable for these conditions.

It is worth pointing out, however, some exceptions to the above that have occurred in practice. W. M. Wilson of the University of Illinois reports[7] on the failure of the sole plates of a bridge. Thomas, in the bulletin previously referred to, showed that the shear stress calculated in this case as only 12,900 pounds per square inch. However, as Thomas points out, the thickness of the plate was only 1.45 $a$, which compares with the infinite thickness assumed in the theory.

Lack of space prohibits extended discussion. We will conclude with a brief reference to the roller pawl shown in *Fig.* 96 and illustrated in the tool of

[7] *Bulletin* No. 162, University of Illinois Eng. Exp. Sta.—1927.

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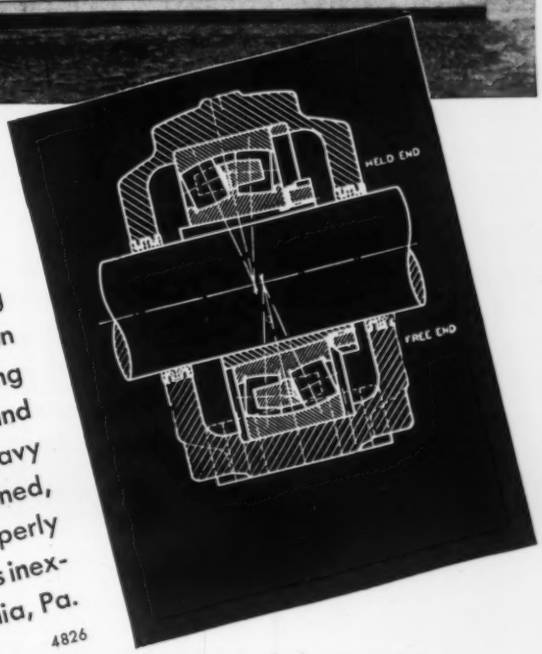


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*Fig.* 8[8]. These parts were originally designed as illustrated in *Fig.* 97. A new tool was needed, built on the same frame but having twice the loading. Since the pawl was already loaded to the limit this apparently meant a larger diameter with a loss of the old frame in the new design. Instead, however, an eccentric radius at the point of contact was provided as shown in *Fig.* 98. Other changes reduced the increase in loading at the pawl to 75 per cent. From *Fig.* 92, steel roller on steel plane, it is necessary to increase the radius the same proportionate amount as the load, to maintain the stress. This gives a radius of $1.75 \times 280 = .490$, which was provided in the .5 radius shown in *Fig.* 98. Note also how the load was shifted further inside the roller, the better to establish the assumed theoretical conditions. This and the radius change, together with closer inspection for bearing alignment in the frame, has made possible the increase of load on these parts by 75 per cent without any increase in size, and with no failures in over a two-year period since being placed in production.

[8] MACHINE DESIGN, March, 1941.

## Combatting Problems in Design of Pressure Vessels

(*Continued from Page* 68)

body and absence of a jacket (except a light-gage shield for insulation) are also advantages in favor of this type of heating. Operating costs are, however, relatively high, but they may be low in plants generating their own power or where electric power is cheap. Electric strip heaters can be grouped in circuits so that sectionalized heating can be provided to accommodate batches of varying sizes. Such an application is shown in *Fig.* 1.

Electric radiant heaters may also be used for heating the charge. Here the heating elements are attached to the inside surface of the outer jacket so that heat radiates across a narrow air gap to the autoclave body. This method has the advantage of freedom from possible short-circuiting and damage to the autoclave body—a condition which sometimes occurs in the improper installation of convection heaters.

A third method of utilizing electric energy for the heating of autoclaves is that of heating by an inductive coil. Here the heat is generated in the steel autoclave body by the induced currents from a coil surrounding the body. Heating is accomplished quickly and uniformly across the autoclave wall.

Steam or hot oil, circulating through a pipe coil immersed in the liquid charge within the autoclave, as in *Fig.* 4, is another method often employed either to avoid the use of an outer jacket, or as a supplementary heating surface to that of the jacket. In the latter case, rapid heating of the charge can be accomplished more easily.

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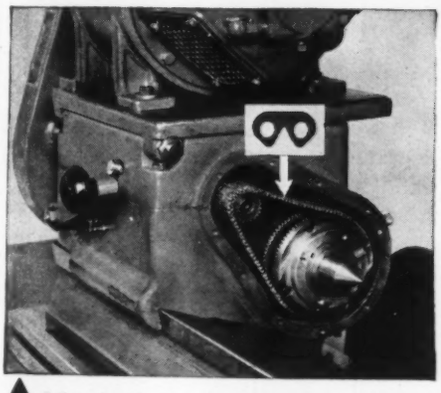

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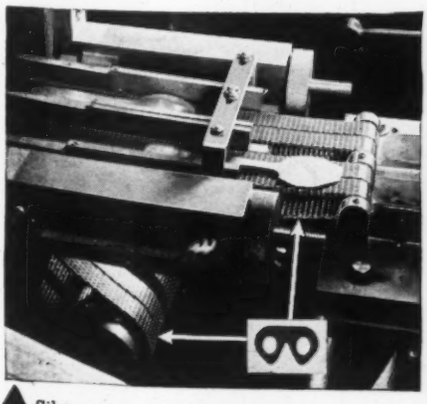

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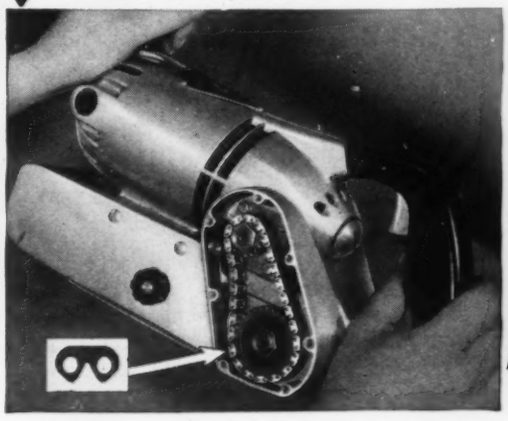

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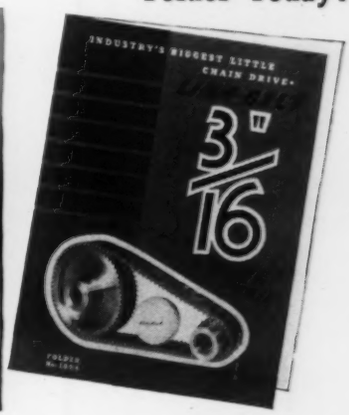

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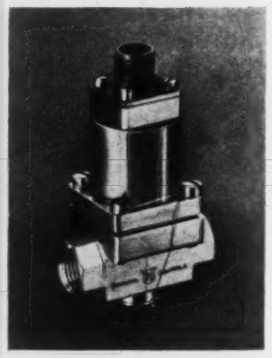

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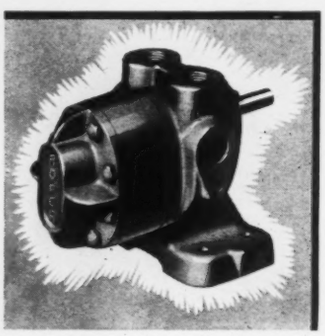

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chemical engineering. There is no equation that can be used to calculate the degree or speed of mixing under a given set of conditions. Because of the fact that the mixing art is of such an empirical nature, and because of the almost infinite variety of substances to be mixed, the number of types of mixers which have been developed are enormous.

Mixing may be (*a*) a physical blending of two or more miscible fluids or uniformly divided solids; (*b*) a solution, which seeks the passing of gas, liquid or solid into another phase, or which may result in a precipitation of crystals; (*c*) a dispersion, which may be a suspension or emulsion; and (*d*) a chemical reaction. Since in the application of a high pressure autoclave the most frequent aim in the agitation of the charge is the promotion of a chemical reaction, such as neutralizing, precipitating, hydrogenating of oils, hydrolizing of starches to sugars, etc., this article will be limited to those types of mixers here employed—high-speed propellers and turbines.

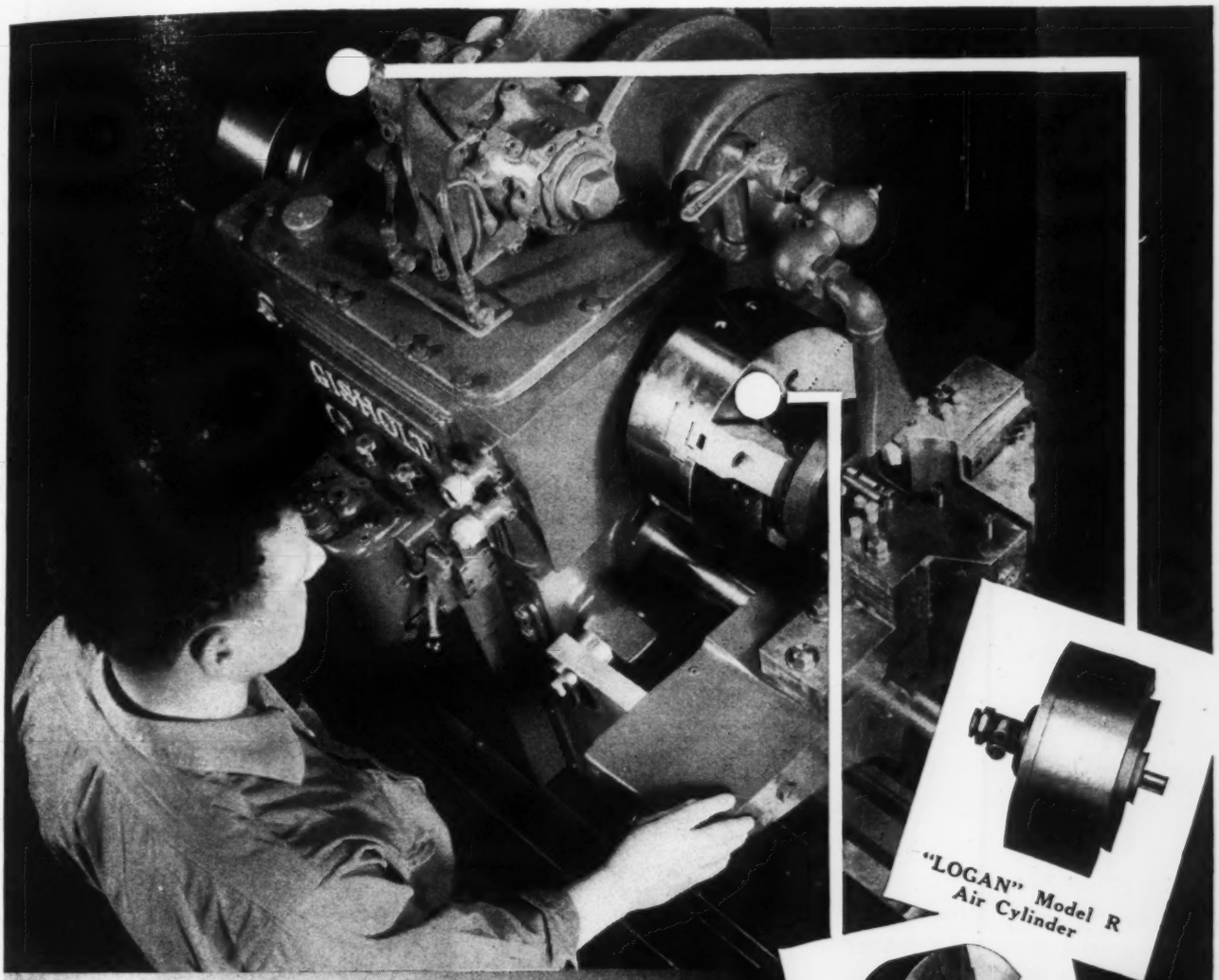
### Propellers Best for Low Viscosities

Propellers are most effective for liquids whose apparent viscosity does not exceed 2000 centipoises, with or without the presence of light solids. They are also used effectively to give circulation and mixing of gases. Usually one impeller is mounted high on the vertical shaft to push the liquid or gas stream downward, and a lower propeller to push the stream upward. The meeting of these two streams results in a deflection outward in a horizontal direction—a highly desirable change of direction. The shaft may be located off center, to prevent too much swirling of the contents. A chart for the calculation of power requirements is given in *Fig.* 2.

Turbine type mixer is best described as a centrifugal pump and its work can be translated into pumping capacity. Liquid or gas enters the impeller axially through the central opening, is accelerated by the vanes, and finally discharged tangentially from the impeller at high velocity. The entire direction change from vertical to horizontal and radial is thus accomplished smoothly with the smallest possible loss of kinetic energy. As a result, the radial currents are still travelling at high velocity at the remote parts of the container.

Turbines will mix all liquids with liquids, and probably excel all types for mixing viscous liquids and for producing fine dispersions. They are the fastest of all types. Their power consumption, as can be seen from the graph, *Fig.* 3, is moderate. They are also the most satisfactory for continuous work. They have no starting torque, so that they can readily "dig" themselves out of sand, sediment or crystalline precipitate of similar properties, to a depth of several feet. Although the turbine imparts velocities to the liquid as high as does the high-speed propeller, the turbine does so at a lower shaft speed than the propeller. This condition greatly prolongs the life of shaft bearings and stuffing box packing. Another important attribute of

(*Continued on Page* 128)





"LOGAN" Model R Air Cylinder

"LOGAN" Model 350-B Chuck

# "LOGAN"

## AIR CHUCKING AS APPLIED TO GISHOLT HYDRAULIC AUTOMATIC LATHE

**This Gisholt No. 12 Hydraulic Automatic Lathe is equipped with a 12″ diameter "LOGAN" Model 350-B Three Jaw Chuck and a Model R Rotating Type "LOGAN" Air Cylinder. The "LOGAN" Chuck is designed to provide extra power and exceptional jaw rigidity in heavy duty chucking service. The "LOGAN" Double Acting Air Cylinder has a 10″ bore and 1¼″ stroke and is designed for the economical operation of air chucks required to be mounted on a revolving spindle. This heavy duty "LOGAN" equipment assures positive chucking and operating efficiency. "LOGAN" Representatives and "LOGAN" Engineers will be glad to make recommendations on your chucking problems.**

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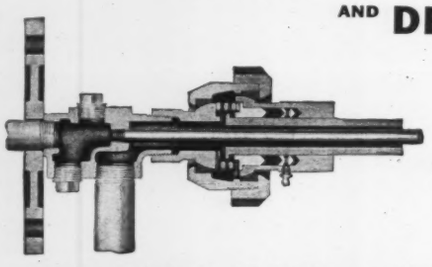

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(*Continued from Page* 122)

the turbine is that its power consumption does not materially increase with higher viscosity of the liquid charge. Although the surface drag, due to viscosity, increases, the pumping capacity of the turbine decreases, and the net result is but a slight increase in power consumed. To offset these advantages, their structure is more complex than that of the propeller and their first cost is usually somewhat higher. Not only is their power consumption greater than that of the propeller but, because of the greatly reduced shaft speed at which turbines rotate, they require larger speed reduction units than do the propeller agitators.

The subject of mixing naturally brings us to a study of the means of transmitting power to the agitators. The lineshaft method of power transmission of a quarter of a century ago has given place to individual drives which not only present neater installations but provide greater flexibility of operation and lower maintenance cost.

### Gearhead Motor Ideal for Turbines

The gearhead motor is one of the most satisfactory means of delivering power to the mixer shaft at the lower speeds required for propellers or turbines. Supporting structure for such a drive unit is of the simplest character. Where several speeds are desired for mixing, a two, three or even four-speed motor can be used. The motor can be of the open, enclosed or explosion-proof types. This drive unit is perhaps the least expensive of the individual drives in current use.

Another good arrangement for driving the agitator shaft consists of a wormgear speed reducer coupled to a separator motor, either by means of a flexible coupling (for constant speed) or by a V-belt and pulleys which permit variation in final output speed by varying the effective diameter of the pulleys. Although this drive unit combination is more expensive and requires a more complex structural support, it has the advantage of easier replacement of either the motor or reducer.

Agitator shaft should, wherever possible, be connected to the speed reduction unit by means of a flexible coupling, and the thrust and radial loads on the shaft carried by an independent bearing assembly. Such an arrangement protects the shaft against possible misalignment, and relieves the speed reduction unit of excessive load.

### Function of Stuffing Box

No agitated autoclave can function properly without an effective stuffing box at the point where the agitator shaft passes through the autoclave body to join the prime mover. A good stuffing box must primarily seal the pressure within the autoclave, and yet permit the agitator shaft to rotate freely and without undue overheating. It must provide proper guidance for the shaft to maintain its alignment and thus prevent "whipping." It must provide means for the removal of excess heat which

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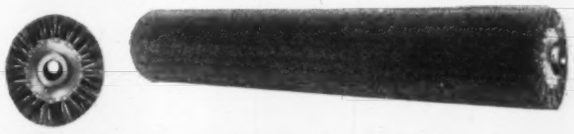

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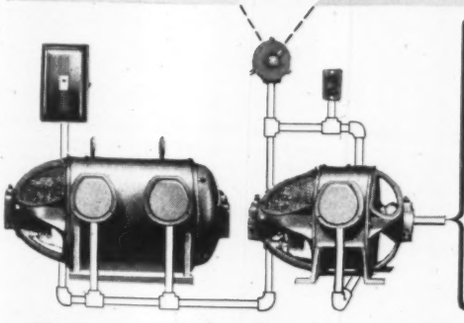

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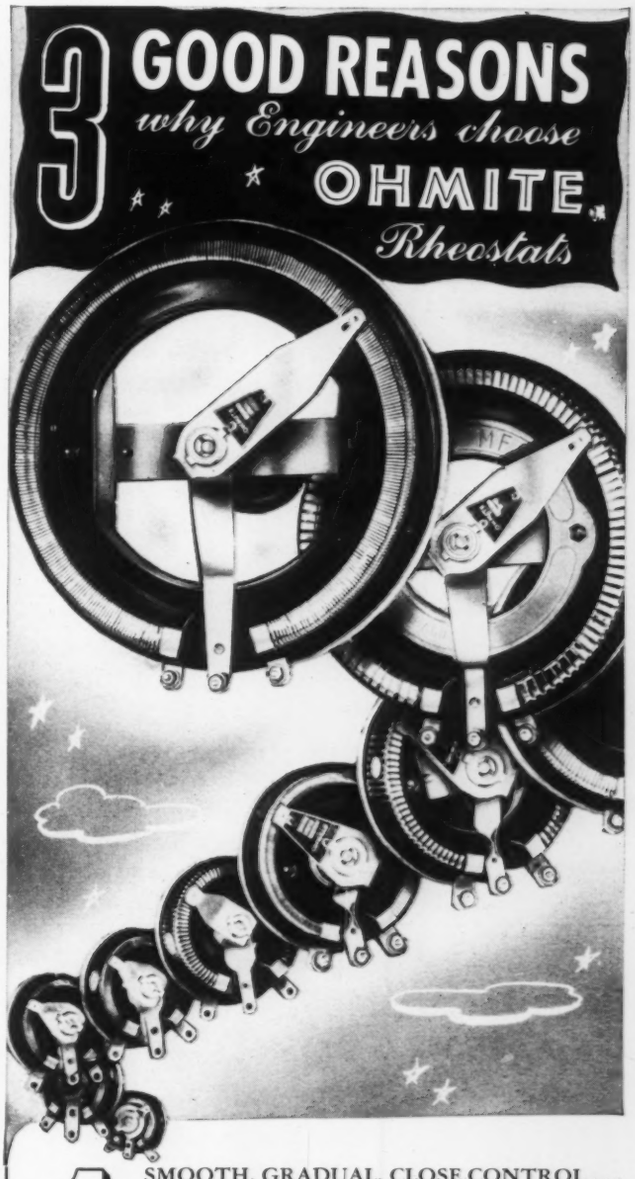


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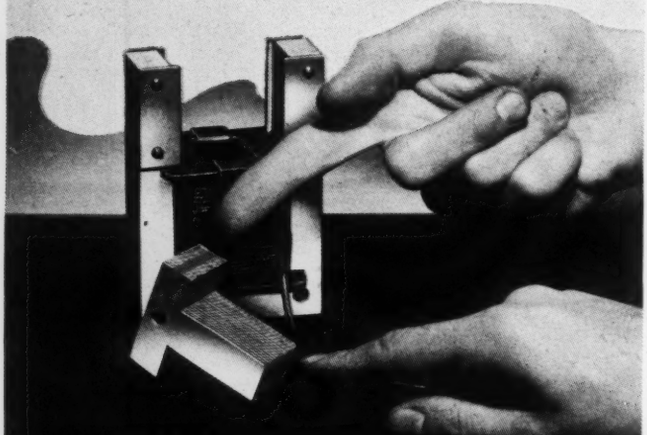

ELECTRICAL MANUFACTURING DIVISION
THE NATIONAL ACME COMPANY
CLEVELAND, OHIO


may be conducted through the shaft from the charge, or which may be generated from the friction of the bearing and packing. And finally, it must be so constructed that all sections are easily accessible from the outside, for assembly or replacement.

Packing should be of the inverted V type. Asbestos cloth and rubber compound are combined and molded into concentric rings. The hinge-like shape of these rings permits them to expand and contract automatically to compensate for variations in pressure within the autoclave, thus making the packing self-sealing. So sensitive and quick-acting is this style of packing that no wrench need be used on the gland bolts.

Watercooling of the stuffing box, as shown in *Fig.* 5, is also an effective means of maintaining a good stuffing box. The heat within the autoclave passing up along the shaft, augmented by the heat of friction generated in the bearing and in the packing, must be reduced to avoid harm to the integral parts of the stuffing box. Such cooling is easily maintained by surrounding the stuffing box with a jacketed annular space through which cooling water is circulated.

# Meetings and Expositions

**Oct. 6-11**

**Exposition of Power and Mechanical Engineering** to be held at the International Amphitheatre, Chicago. Charles F. Roth, Grand Central Palace, New York, is manager.

**Oct. 13-14—**

**Steel Founders' Society of America.** Fall meeting to be held at The Homestead, Hot Springs, Va. Raymond L. Collier, 920 Midland building, Cleveland, is secretary.

**Oct. 13-16—**

**Marking Device Association.** Annual meeting to be held at the Palmer House, Chicago. Homer G. Klene, 431 South Dearborn street, Chicago, is secretary.

**Oct. 16-18—**

**American Society of Tool Engineers.** Semiannual convention to be held at Royal York hotel, Toronto, Canada. Ford R. Lamb, 2567 West Grand boulevard, Detroit, is executive secretary.

**Oct. 19-24—**

**American Welding Society.** Annual meeting and convention to be held in conjunction with the National Metal exposition, Philadelphia. Headquarters are at Bellevue-Stratford Hotel. M. M. Kelly, 29 West Thirty-ninth street, New York, is secretary.

**Oct. 20-24—**

**American Society for Metals.** Annual meeting and exposition to be held at the Benjamin Franklin hotel, Philadelphia. W. H. Eisenman, 7301 Euclid avenue, Cleveland, is secretary.

**Oct. 20-25—**

**Dairy Industries Supply Association Inc.** Exposition and meetings are to be held in Toronto, Canada. Roberts Everett, 232 Madison avenue, New York, is executive vice president.

**Oct. 30-Nov. 1—**

**Society of Automotive Engineers.** National Aircraft Production meeting and engineering display to be held at the Biltmore Hotel, Los Angeles. John A. C. Warner, 29 West Thirty-ninth street, New York, is secretary.

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A complete line of "Flea Power" A.C. and D.C. back-geared motors in both cased and skeleton types that offer an unlimited range of speeds and torques . . . dependable motor, literally hundreds of thousands in use. Produced in large quantities and sold at quantity production prices, they make possible *motorized* controls, *automatic* tuning, *animated* displays, etc. Both flexible standard types and strictly special application motors, one or a million on short notice.

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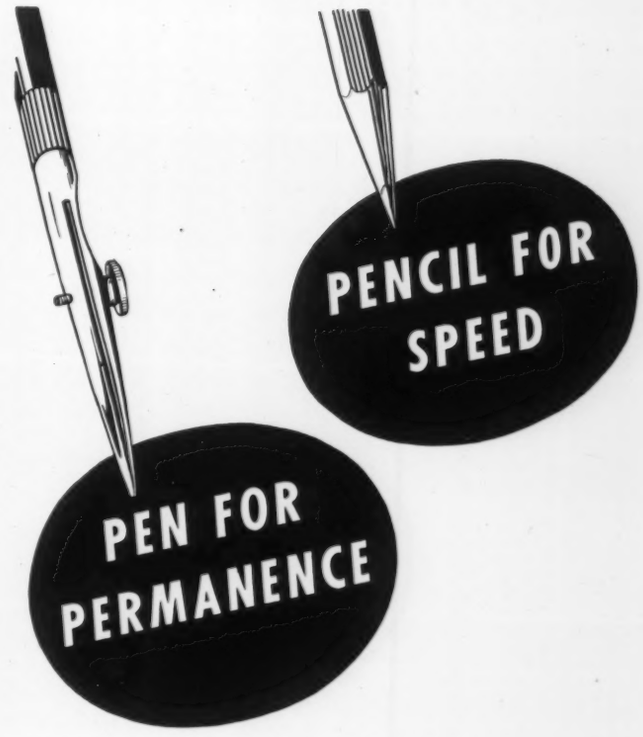


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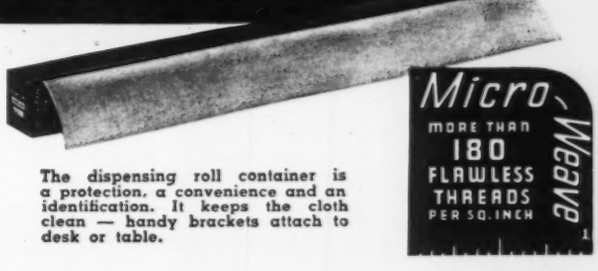


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# Business and Sales Briefs

Large factory and office building has just been completed by Charles Bruning Co. Inc., 4700 West Montrose avenue, Chicago, manufacturers of sensitized papers and printing and developing machines. The machine shop, which occupies an area of 14,600 square feet—almost half of the first floor area—is modern in every sense of the word.

♦

Formerly Chicago representative for McKenna Metals Co., Latrobe, Pa., B. E. Middleton has been appointed representative in the Central New York territory, with headquarters at 217 East avenue, Rochester, N. Y.

♦

According to a recent announcement, Coolidge Sherman has been appointed eastern sales manager of the Allegheny Ludlum Steel Corp., Pittsburgh. In his new capacity Mr. Sherman will act as coordinator of sales in all districts on the Eastern seaboard. Previous to his appointment he was manager of valve steel sales.

♦

Appointment of Victor A. Hanson as general sales manager of Whitney Chain & Mfg. Co., Hartford, Conn., has been announced. Mr. Hanson was previously assistant sales manager and field manager of the company.

♦

A large addition to the factory of The Keystone Carbon Co., Saint Marys, Pa., has just been completed. The new wing will be used for the manufacture of brushes and porous bronze bearings. Another foundation has been laid for a large plant addition to house new equipment for making negative temperature coefficient resistors.

♦

W. C. Stauble, chairman of The Holo Krome Screw Corp., Hartford, Conn., has been appointed chairman of the Industrial Supplies Defense Committee of the Industrial Supplies Industry.

♦

Fifty years of progress and achievement has been celebrated by the Chain Belt Co., Milwaukee. Founded in 1891 for the purpose of producing an improved type of detachable chain, then used mainly on agricultural machinery, the company has since expanded its activities and is today recognized as one of the largest producers of chain belts.

♦

Miniature Precision Bearings has moved its plant to Keene, N. H., according to anannouncement made recently.

♦

Expans'on of the manufacturing facilities of C.P. Clare & Co., Chicago, has recently been made. The company, manufacturing multiple-contact relays, keys, switches, and associate electro-mechanical apparatus, now occupies its new daylight plant located at Sunnyside and Keating avenues, Chicago.

♦

R. S. Ernst has been appointed representative for Hele-Shaw Pump division, American Engineering Co., Philadelphia, in the territories of Indiana, Wisconsin and part of Illinois. His headquarters will be Room 329, 844 Rush street, Chicago.

♦

Succeeding Robert J. Frank, William J. McIlvane has been named general manager of sales, Copperweld division, Copperweld Steel Co., Glassport, Pa.

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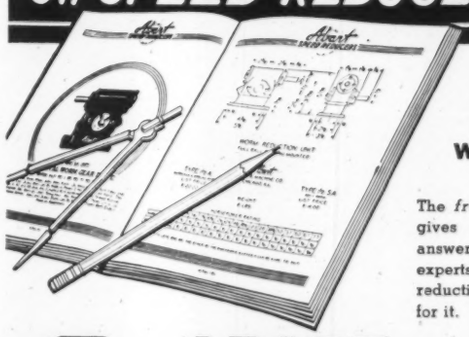

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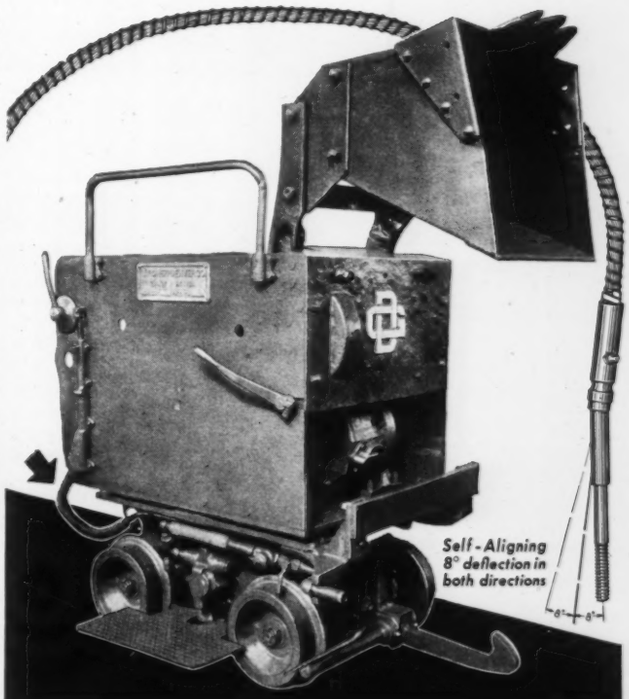


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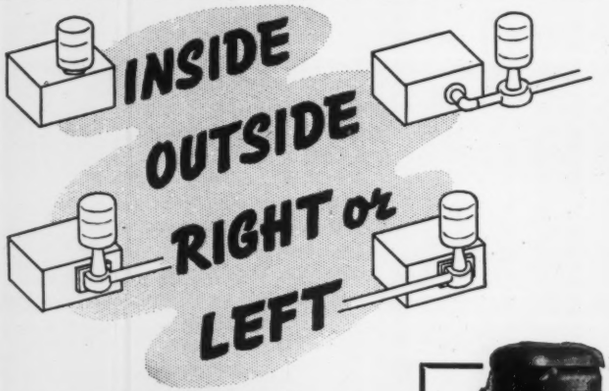


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**GUSHER**
**COOLANT PUMPS**

*Adaptability* is only one of the many advantages of GUSHER Coolant Pumps.

Sturdy vertical shaft on ball bearings, double suction intake giving balanced impeller are outstanding features.

There's a Gusher model to *speed* your work. Write for data and specifications.

P3 models are available in immersed type (1-P3), flange-mounted with internal discharge (2-P3), flange-mounted with external right hand discharge (3-P3), left hand discharge (4-P3). All above are available in 2 short and long models, that is, for two maximum high water lines.

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LARGEST EXCLUSIVE BUILDERS OF COOLANT PUMPS

Mr. McIlvane was formerly sales promotion manager. Mr. Frank formerly vice president in charge of sales, continues as vice president and director of the company.

♦

B. E. Sivyer, previously San Francisco branch manager of Chain Belt Co., Milwaukee, has been transferred to the head office as assistant sales manager of the chain belt and transmission division. He has been with the company ten years. S. Y. Warner, who joined the company in 1930, replaces Mr. Sivyer as manager at San Francisco.

♦

To succeed J. B. Strauch as president, William B. Given Jr. is the new president of National Bearing Metals Corp., New York. Mr. Strauch has been elected chairman of the board this position previously being held by Mr. Given. Mr. Given is also president of American Brake Shoe and Foundry Co., which owns a controlling interest in the National Bearing Metals Corp.

♦

For eleven years assistant district engineer, General Electric Co., Chicago, Truman G. Glenn has been appointed engineer of the Detroit office. He replaces Thomas E. Nicoll, who recently retired.

♦

William K. Cusick has joined International Rustproof Corp., Cleveland, and will be in charge of engineering and sales for the Irco zinc coat division. Formerly Mr. Cusick was with Parker Rustproof Co. Detroit.

♦

With headquarters at 50 Church street, New York City, Edward M. Kimball has been named New England representative for McKenna Metals Co., Latrobe, Pa.

♦

Associated with Stoody Co., manufacturer of hardfacing metals, Whittier, Calif., for more than six years, J. R. Spence has been promoted to general sales manager. He had previously served as chief metallurgist and industrial sales manager.

♦

In addition to his design and development activities, Charles A. Arens, president of Arens Controls Inc., 2250 South Halsted street, Chicago, has taken over the duties of sales manager. Calhoun Norton continues as vice president, and has been appointed general manager. A graduate of Rensselaer, Richard Frost becomes the new chief engineer of the company.

♦

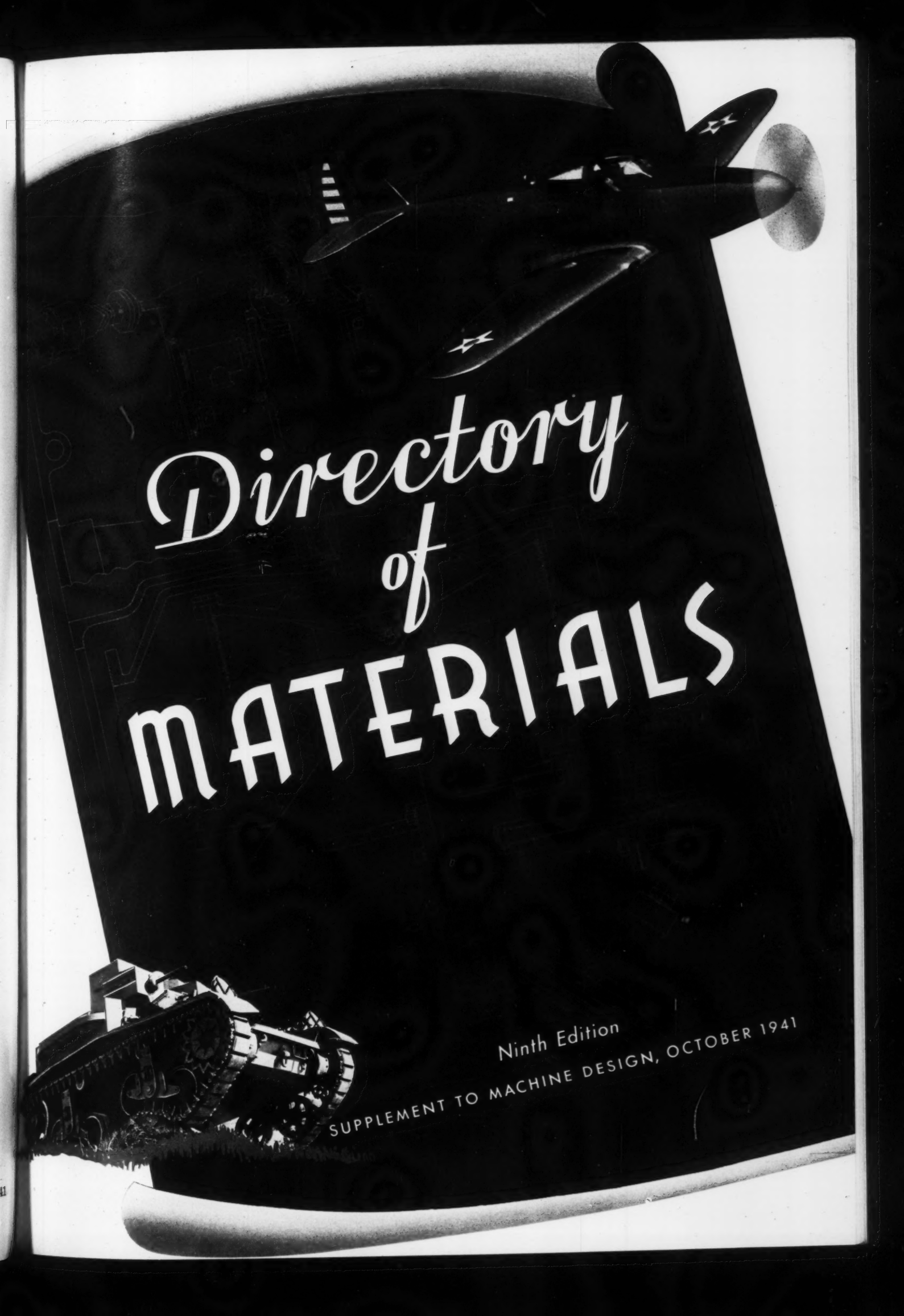
With headquarters at Dallas, Harry McCool Jr. has been appointed southwestern sales representative, steel and tube division, Timken Roller Bearing Co. His territory includes Kansas, Louisiana, Oklahoma, Arkansas and Texas.

♦

Heretofore sales representative in the Cincinnati district for the mechanical division of B. F. Goodrich Co., Akron, O., O. C. Mueller has been transferred to Pittsburgh. In Cincinnati he is suceeded by A. C. Lutz. J. M. Cooney has been transferred from Cincinnati to Dayton, O.; B. E. Silver, connected with the manufacturers' sales department in Washington, has been transferred to the hose sales department at Akron, and J. V. Powers becomes field representative of the New York district with headquarters in Albany, N. Y.

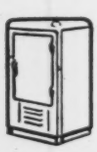
♦

The fifth plant of General Electric Co., Schenectady, N. Y., to manufacture plastic parts was formally placed in operation at Taunton, Mass., recently. It will add approximately 25 per cent to the company's plastic production and will be the third largest molding plant in the United States.


Directory
of
MATERIALS
Ninth Edition
SUPPLEMENT TO MACHINE DESIGN, OCTOBER 1941

# Sabeco BRONZE

## BEARINGS WITHSTAND MORE PUNISHMENT—NEED LESS LUBRICATION—WILL NOT POUND OUT—CANNOT SCORE OR SEIZE SHAFTS



Due to its unusual qualities, "SABECO" Bronze is the ideal bearing bronze for almost any application where loads are heavy or lubrication difficult.

"SABECO" Bearing Bronze has proven its value as seals for high pressure gas, oil, corrosive chemicals, water and fuel-oil pumps and refrigeration and air conditioning equipment.

"SABECO" is doing an outstanding job when used for lead screw nuts, liners for acid or corrosive fluid pumps, sleeves and bearings for machine tool equipment.

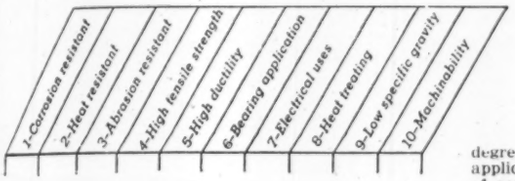
"SABECO" Bearing Bronze is available in completed bearings, bar stock, sleeves, rough castings, and ingots. Write our engineers today for information about how "SABECO" Bronze can help improve the efficiency of your product.

**SAGINAW BEARING COMPANY • SAGINAW, MICHIGAN**

867 SOUTH WATER STREET — CABLE ADDRESS "SABECO"

# Iron, Steel and Nonferrous Metals Listed by Tradenames

*(For listing by producing companies, and complete street addresses, see Page 60-D. For index of alloys by principal constituents, see Page 48-D)*




## A

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**ABRASOWELD**—Lincoln Electric Co., Cleveland. Arc-welding electrode for providing abrasion resisting, self-hardening deposit which hardens rapidly under impact and abrasion; maximum hardness develops at surface, leaving cushion of softer metal beneath; provides resistance to abrasion in straight carbon, low alloy or high manganese steel surfaces; effective on gear and pinion teeth.

1 - - - - - - - - - -

**ACME COLORSTRIP**—Acme Steel Co., Chicago. Strip steel, electro-galvanized and coated on one or both sides with any specific color (coating may be either enamel or lacquer); furnished in coils and can be fabricated by rolling or stamping; corrosion resistant; resists heat up to 150 degrees Fahr.; same tensile strength, elongation and hardness as any strip steel with slight variations depending on temper and analysis of the base metal.

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**ACORN**—A. W. Cadman Mfg. Co., Pittsburgh; babbitt metal furnished in ingots; brinell hardness 70 degrees Fahr. 23.8, 212 degrees Fahr. 21.8; compressive strength 12,500 lbs. per sq. in.; for bearings having reciprocating motion, subject to excessive pound or vibration.

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**ADAMANT SUPER-GENUINE BABBITT**—Magnolia Metal Co., Elizabeth, N. J. Over 90 per cent tin, free of lead, containing special fluxes; furnished as ingots; specific gravity 7.34; bearing properties good; brinell hardness, untreated 23; used for bearings, diesel engines, connecting rods, etc., subject to shock or strain.

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**ADAMANTINE**—Babcock & Wilcox Co., New York. Special steel castings with wear-resisting qualities and machinable surfaces; for grinding mills, mixers, conveyors, power shovels.

***See advertisement, Page 65-D***

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**ADMIRALTY METAL, Bulldog Brand**—Phelps Dodge Copper Products Corp., New York. Copper 70, zinc 29, tin 1, furnished in tubing, sheets and strips for extruding, welding and drawing; corrosion resistant; resists heat to 450 degrees Fahr.; tensile strength 45,000-60,000 lbs. per sq. in.; high ductility; for condenser tubes.

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**ADNIC**—Scovill Mfg. Co., Waterbury, Conn. Copper 70, nickel 29, and tin 1; furnished in rods, bars, tubes, wire, sheets, strips and plates for stamping, turning, boring, welding, deep drawing, cold heading, and brazing; resists corrosion due to organic acids, alkalies, sulphur compounds; resists heat up to 600 deg. Fahr.; tensile strength 55,000 to 130,000 lbs. per sq. in.; recommended heat treatment, annealing, 1100 to 1300 deg. Fahr.; brinell hardness, untreated, 70 to 200; used for condenser tubes and heat exchanger tubes.

- 2 - - - - 7 - - -

**ADVANCE**—Driver-Harris Co., Harrison, N. J. Copper 55, nickel 45; resists heat up to 1500 degrees Fahr.; thermocouple material. For application where low temperature coefficient of resistivity is required; also for measuring instruments, industrial and radio rheostats and elevator controls.

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**AERISWELD**—Lincoln Electric Co., Cleveland; arc-welding electrode; for welding of bronze, brass and copper either in manufacturing or maintenance work.

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**AETERNA 600 METAL**—Allied Process Corp., New York. 60:40 brass base with manganese and silicon; furnished in rough bars or billets, finished rods or bars and tubing for hot forging and extruding; corrosion and abrasion resistant; tensile strength 85,000 lbs. per sq. in.; medium ductility; good bearing properties and weldability; used for gears, levers, cams, cranks, etc.

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**AGILE**—American Agile Corp., Cleveland. Light-gage electrodes for sheet metal welding; fillet welding electrodes; for cast iron welding, hard-surfacing and other purposes.

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**AGRICOLA**—Saginaw Bearing Co., Saginaw, Mich.; a bearing bronze of copper 70, lead 30; impurities less than .2 of 1; resists corrosion caused by acids; resists heat to 500 degrees Fahr.; ductility medium; especially adapted for diesel engine bearings and airplane bearings.

***See advertisement, Page 2-D***

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**ALCLAD**—Aluminum Co. of America, Pittsburgh. Duplex aluminum and aluminum base alloys. An example is sheet with a high-strength core (ALCOA alloy 17S or 24S) and a coating of relatively high purity aluminum with high resistance to corrosion.

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**ALCOA**—Aluminum Co. of America, Pittsburgh. Aluminum wrought and casting alloys as follows:

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3S-¼H; manganese 1.2, balance aluminum plus normal impurities; finished rods or bars, extruded shapes, tubing, wire, sheets, strips and plates, for stamping, extruding, welding, spinning, riveting, drawing, etc. Resists corrosion caused by all atmospheres, sea water, numerous chemicals; melts at about 1200 Fahr.; tensile strength, ult., 17,000 lbs. per sq. in. min.; ductility, high; bearing properties, fair; nonmagnetic; weldability, good. Used for low-stressed parts where high workability and resistance to corrosion are required.

3S; also available in tempers soft to hard, tensile strength ult. (min.) 14,000-27,000 lbs. per sq. in.; ductility decreases with increased tensile strength.

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11S-T3; copper 5.5, lead .5, bismuth .5, balance aluminum plus usual impurities; finished rods or bars, wire and forgings, for turning, boring, etc. Resists corrosion caused by mild industrial atmospheres; not recommended for use above 250 Fahr. Tensile strength, ult., 38,000-45,000 lbs. per sq. in. min.; medium ductility; fair bearing properties; nonmagnetic; specific gravity 2.82. A free-machining alloy for automatic screw machine work where moderately high strengths and fair resistance to corrosion are required.

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17S-T; copper 4, manganese .5, magnesium .5, balance aluminum plus usual impurities; finished rods or bars, tubing, wire, strips, plates, forgings, extruded and rolled shapes, for stamping, turning, riveting, hot forging, etc. Resists corrosion caused by industrial atmospheres; not recommended for use above 250 Fahr. Abrasion resistance, medium; tensile strength, ult., 50,000-58,000 lbs. per sq. in. min.; medium ductility; specific gravity 2.79; fair bearing properties; nonmagnetic. Used where high strength, moderately high resistance to corrosion and fair machinability are required.

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24 S-T; copper 4.5, manganese .6, magnesium 1.5; furnished in finished rods or bars, tubing, wire, sheets, plates or extruded shapes; for stamping, extruding, turning, welding and riveting. Has high resistance to corrosion in ALCLAD 24-S-T form; low abrasion resistance; tensile strength, ult., 57,000-70,000 lbs. per sq. in., min.; ductility, low; specific gravity, 2.77; nonmagnetic; for aircraft structural parts.

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52S-½H; magnesium 2.5, chromium .25, with balance aluminum and usual impurities; finished rods or bars, tubing, wire, sheets, strips and plates, for stamping, welding, riveting, turning, etc. Resists corrosion caused by all atmospheres; melts at about 1200 Fahr., softens at 650 Fahr.; tensile strength, ult., 34,000 lbs. per sq. in. min.; medium abrasion resistance and ductility; specific gravity 2.67; fair bearing properties; weldability, fair; nonmagnetic. Used for parts in which high resistance to corrosion and moderate strength are required.

52S; also available in tempers from soft to hard, tensile strengths from 25,000-38,000 lbs. per sq. in.; ductility decreases as tensile strength increases.

53S-T; magnesium 1.3, silicon .7, chromium .25, balance aluminum plus usual impurities; finished rods or bars, tubing, wire, sheets, strips, plates, forgings and rolled and extruded shapes, for stamping, hot forging, welding, riveting, turning, etc. Resists corrosion caused by all atmospheres; softens at 400-650 Fahr.; tensile strength, ult., 32,000-35,000 lbs. per sq. in. min.; ductility, medium; specific gravity 2.69; bearing properties, fair; nonmagnetic. Used where high resistance to corrosion and moderately high strength and workability are required.

61S-T; magnesium 1.0, silicon .6, copper .25, chromium .25, balance aluminum plus usual impurities; tubing, sheets, plates and extrusions, for stamping, turning, boring, welding, riveting, spinning, drawing, etc. Corrosion resistant; softens at 650 Fahr.; medium abrasion resistant; tensile strength, ult., 38,000-42,000 lbs. per sq. in. min.; specific gravity 2.7; nonmagnetic. Used where moderate strength, good workability (forming), fair machinability are required.

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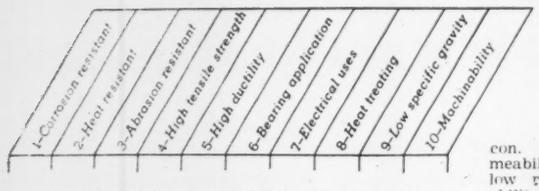
13; silicon 12, balance aluminum; furnished as die castings; resists corrosion caused by industrial and sea coast atmosphere; medium abrasion resistance; tensile strength, ult., 33,000 lbs. per sq. in.; specific gravity 2.66; fair bearing properties; nonmagnetic; weldability, good. For control and instrument cases, small frames and housings, nameplates, covers, conveyor links, etc.

43; silicon 5, balance aluminum; furnished as castings; resists corrosion caused by industrial and sea coast atmosphere; medium abrasion resistance; minimum tensile strength, ult., 17,000 lbs. per sq. in. for sand castings, and 21,000 lbs. per sq. in. for permanent mold castings; medium ductility; specific gravity 2.66; nonmagnetic;




brinell hardness, untreated, 40. Used for control and instrument cases, nameplates covers, splash guards, housings, etc.

112; copper 7.0, iron 1.2, zinc 1.7, balance aluminum; furnished as sand casting. Resists corrosion caused by industrial atmospheres; medium abrasion resistance; tensile strength, ult., 19,000 lbs. per sq. in., min., respectively; specific gravity 2.85; fair bearing properties; nonmagnetic; brinell hardness 70 untreated. Used for gear cases, covers, bases, handwheels, small housings and other parts not subject to high stresses or impact.

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195 and B195. No. 195: copper 4, balance aluminum; No. B195: copper 4.5, silicon 2.5, balance aluminum. Both grades furnished as castings: No. 195 for sand casting and No. B195 for permanent mold castings; corrosion resistant; medium abrasion resistance; tensile strength, ult., 29,000-36,000 lbs. per sq. in. for sand casting and 33,000-35,000 lbs. per sq. in. min., for permanent mold casting; high ductility; specific gravity 2.77-2.79; bearing properties, fair; nonmagnetic; brinell hardness, heat-treated, 65-95. Used for turrets, shaper rams and links, boring machine heads, planer tables, head and tail stocks, control levers, etc.

356; silicon 7, magnesium .3, balance, aluminum; furnished as castings; corrosion resistant; medium abrasion resistance; tensile strength, ult., 23,000-30,000 lbs. per sq. in., for sand castings; 28,000-33,000 lbs. per sq. in., min., for permanent mold castings; medium ductility; specific gravity 2.63; bearing properties, fair; nonmagnetic; brinell hardness, heat treated, 55-80. Used for pneumatic and hydraulic cylinders for presses, chucks and other intricate castings.

14S; copper 4.4, silicon .8, manganese .8, magnesium .4, balance aluminum; furnished as forgings; corrosion resistant; medium abrasion resistance; tensile strength, ult., 65,000 lbs. per sq. in., min.; ductility, medium; specific gravity 2.8; nonmagnetic; brinell hardness, heat treated, 130 min. Used for connecting rods and reciprocating linkage, ball cranks, hand levers, and other parts where maximum strength is required.

A 51S; silicon 1, magnesium .6, chromium .25, balance aluminum; furnished as forgings; corrosion resistant; medium abrasion resistance; tensile strength, ult., 44,000 lbs. per sq. in., min.; specific gravity 2.69; nonmagnetic; weldability, good; brinell hardness, heat treated, 90 min. Used for control levers, bell cranks, reciprocating linkage, pneumatic cylinders and pistons, small gears, etc.

Lynite: Aluminum forged and cast products. Descriptions of the alloys in which these products are available will be found under the listing Alcoa. This material is also designated by the tradename Alcoa, and the foregoing grades are described in full under that tradename.

1 - - - - - - 7 - - -

**ALCUMITE**—Duriron Co. Inc., Dayton, O. Copper 90, aluminum 9, iron 1; for pumps, valves, pipe, fittings, bars and castings for corrosive service where a copper base alloy is preferred.

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**ALLEGHENY LUDLUM** — Allegheny-Ludlum Steel Corp., Pittsburgh.

"4750"; furnished in rods, sheets, coiled strips and laminations for stamping, forming and drawing. Nickel 47 to 50, balance iron. Has very high permeability when dry hydrogen-annealed after fabrication; recommended heat treatments, 1800 to 2000 degrees Fahr. in dry hydrogen; used in audio transformers, sensitive relays and electrical instruments.

"88"; furnished in rods, sheets and plates for stamping, boring and welding. Nickel, 6½ to 14; manganese, 5-12; balance, iron. Is nonmagnetic whether hard-worked or soft-annealed. Weldability, fair; recommended heat treatment, 1400 to 1475 degrees Fahr. Used where strength is required combined with nonmagnetic properties.

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Electrical steels furnished in sheets and coiled strips for stamping; ½ to 4½ per cent silicon according to requirements. Has magnetic and electrical properties, high permeability; high electrical resistance; nonaging; above 1½ per cent silicon content; good surface insulation; fair weldability; recommended heat treatment, 1400 to 1450 degrees Fahr.; used for motor laminations.

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Relay steels furnished in rods or bars for turning, boring, etc.; 1 to 2½ per cent silicon. Has magnetic properties, high permeability; nonaging; electrical properties; low retentivity, low coercive force; weldability fair; recommended heat treatment, 1500 to 1550 degrees Fahr.

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**ALLEGHENY METALS**—Allegheny-Ludlum Steel Corp., Pittsburgh.

18-8, type 302; carbon over .08-.2, chromium 17.5-20, nickel 8-10; a basic chromium-nickel stainless steel having general corrosion resistance.

18-8-C, type 347; chromium 17-20, nickel 8-12; basic 18-8 analysis modified by addition of columbium for stabilization of alloy within the critical range of 900-1500 degrees Fahr.

18-8-M, type 317; carbon .1 max., chromium 16-18, nickel 10-14; basic 18-8 analysis modified by addition of molybdenum for increased corrosion resistance.

18-8-EZ, type 303; carbon .2 max., chromium 17.5-20, nickel 8-10; basic 18-8 analysis modified to provide free machining properties.

20-10-S, type 308; carbon .08 max., chromium 19-22, nickel 10-12; a chromium-nickel stainless steel designed for certain applications requiring slightly higher general corrosion resistance than that of 18-8 alloy.

25-12, type 309; carbon .2 max., chromium 22-26, nickel 12-14; a chromium-nickel stainless steel for elevated temperature applications requiring ease of fabrication and a high degree of oxidation resistance and high strength and creep values up to 2000 degrees Fahr.

25-20, type 310; carbon .25 max., chromium 24-26, nickel 19-21; a chromium-nickel steel similar to type 25-12 but exhibiting greater stability due to its higher alloy content. Coefficient of expansion is closer to that of plain steel than those of the other chromium-nickel alloys listed.

12, type 410; carbon .15 max., chromium 10-14; a high strength chromium stainless steel possessing excellent resistance to corrosion and oxidation; a type which responds to heat treatment.

42-EZ, type 416; carbon .15 max., chromium 12-14; a steel similar to type 12 but modified to provide free-machining properties.

12-TB, type 403; carbon .15 max., chromium 11.5-13; a high strength chromium steel widely used to meet the exacting requirements of turbine construction which calls for high elastic limit and impact values.

12-2, type 414; carbon .15 max., chromium 10-14, nickel 2 max.; a high strength chromium steel with small nickel content possessing properties of basic Allegheny Metal 12 alloy, but with more definite response to heat treatment.

17, type 430; carbon .12 max., chromium 14-18; a low-carbon, high-chromium structural steel possessing high degree of resistance to chemical and atmospheric corrosion and oxidation up to 1600 degrees Fahr., together with high strength and ease of fabrication.

17-EZ, type 340F; carbon .12 max., chromium 14-18; an alloy similar to Allegheny Metal 17 but modified to provide free-machining properties.

21, type 442; carbon .35 max., chromium 18-23; an 18-23 per cent straight chromium alloy designed primarily for high temperature service in applications not involving difficult fabrication.

28, type 446; carbon .35 max.; chromium 23-30; a straight chromium alloy which offers excellent resistance to chemical corrosion and to oxidation up to 2150 degrees Fahr.

H-17, type 440; carbon over .12, chromium 14-18; a 17 per cent chromium alloy steel with high carbon which through heat treatment develops maximum hardness and wear resistance, together with high strength and corrosion resistance.

M-17, type 440; carbon over .12, chromium 14-18; an alloy similar to H-17 but with lower carbon, possessing increased resistance to corrosion and higher impact values with somewhat lower hardenability.

L-12, type 420; carbon over .15, chromium 12-14; a 12-14 per cent chromium alloy steel which, due to its higher carbon content, can be heat treated to greater hardness than Allegheny Metal 12 and 12-12 with but slight impairment of the corrosion-resistant qualities of either.

46, types 501 and 502; carbon for 501 over .1 and for 502, .1 max.; chromium for both types 4-6; a low chromium alloy structural steel possessing strength and corrosion and oxidation-resistance intermediate to those of plain carbon steel and the regular stainless steels. Available with molybdenum for increasing tensile and creep strengths at high temperatures.

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**ALMO**—Crucible Steel Co. of America, New York.

Forging No. 1; chromium 1, molybdenum .2 forging steel for machine parts requiring high strength and toughness; also available in case carburizing type.

Forging No. 2; chromium 3, molybdenum .5 forging steel requiring high tensile strength with good ductility and high impact even in large sections.

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**ALNICO**—General Electric Co., Schenectady, N. Y. Permanent magnet alloy of high coercive force; nickel 20 to 30 per cent, aluminum 10 to 12, cobalt 3 to 5, balance iron; extremely hard and obtainable in cast form. Available in both sintered and cast form. Sintered Alnico furnished by General Electric and cast Alnico by the following: Arnold Engineering Co., Chicago; Belden Mfg. Co., Chicago; Cinaudagraph Corp., Stamford, Conn.; Crucible Steel Co. of America, New York; General Magnetic Corp., Chicago; Indiana Steel Products Co., Chicago; Simonds Saw & Steel Co., Lockport, N. Y.; Taylor-Wharton Iron & Steel Co., High Bridge, N. J.; and Thomas and Skinner Steel Products Co., Indianapolis.

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**ALUMINWELD**—Lincoln Electric Co., Cleveland. A 5 per cent silicon-aluminum-alloy electrode for arc welding aluminum in any form—cast, sheet, shapes, or extruded forms. For either metallic or carbon arc welding. Welds are very dense without porosity and possess high tensile strength.

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**AMBRAC**—American Brass Co., Waterbury, Conn. Alloy 850; copper 75, zinc 5, nickel 20; high ductility; used for condenser tubes, etc.

*See advertisement, Pages 17-D—20-D*

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**AMERCUT**—American Steel & Wire Co., Cleveland. Cold finished, carbon or alloy, steel bars are heat-treated and manufactured to meet various combinations of definite physical, magnetic, corrosion resistant or machinability property specifications for screw machine use or shafting.

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**AMERICAN**—American Nickeloid Co., Peru, Ill. Bonded metals; chromium, nickel, brass, copper, gold resemblance and colors bonded to base metals such as steel, tin-plate, zinc, brass, copper, aluminum and nickel silver. Available in brilliant finishes and patterns as sheets, flat strips, coiled strip and round edge flat wire. Can be supplied with gum adhered paper covering protecting prefinish in drawing and forming. For parts and trim of coin-operated phonographs, vending and game machines, toys, dispensers, hardware specialties, stoves, refrigerators, automobiles, radios, washing machines, etc.

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**AMERICAN QUALITY**—American Steel & Wire Co., Cleveland. Carbon steels and alloys in the form of cold-rolled strip, manufacturer's wire and springs.

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**AMPCO METAL**—Ampco Metal Inc., Milwaukee. Special copper-base alloys for wear and corrosion-resistant service; produced in seven grades.

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Grade 12; copper 88.2, aluminum 8.6, iron 2.9, others .3; furnished in rods, bars, sheets, and plates, for hot forging, turning, boring and welding; also as sand or centrifugal castings; corrosion resistant; resists heat to 1000 degrees Fahr.; low abrasion resistance; tensile strength 65,000 lbs. per sq. in.; compressive strength 120,000 lbs. per sq. in.; high ductility; specific gravity 7.735; good bearing properties; nonmagnetic; brinell hardness 115; for use as bushings and bearings.

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Grade 16; copper 86.2, aluminum 10.2, iron 3.3, others 0.3; furnished in rods, bars, sheets and plates for hot forging, turning, boring and welding; also as sand or centrifugal castings; corrosion resistant; resists heat to 1000 degrees Fahr.; medium abrasion resistance; tensile strength, 75,000 lbs. per sq. in.; compressive strength, 125,000 lbs. per sq. in.; high ductility; specific gravity 7.628; good bearing properties; nonmagnetic; fair weldability; brinell hardness, heat treated, 137; used for bearings, gears, worm-wheels, liners, lead screw nuts—all for heavy duty where exceptional resistance to wear is required.

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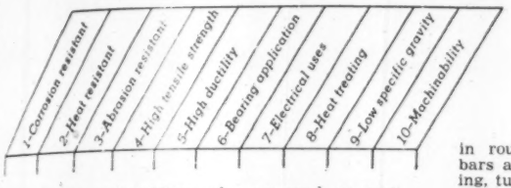
Grade 18; copper 84.6, aluminum 11.3, iron 3.2, others 0.4; furnished in rods, bars, sheets and plates, for hot forging, turning,




boring and welding; also as sand or centrifugal castings; corrosion resistant; resists heat to 1000 degrees Fahr.; tensile strength 80,000 to 85,000 lbs. per sq. in.; compressive strength 136,000 lbs. per sq. in.; medium ductility; good bearing properties; nonmagnetic; brinell hardness, heat treated, 173; for use as heavy-duty, wear-resistant gears, worm-wheels, feed nuts, bearings, welding bases and pickling equipment.

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Grade 18-23; aluminum 10.6-11.2, iron 3.4-4, others .4 max., copper balance; furnished in rough bars or billets and as sand casting for hot forging; resists heat to 750 degrees Fahr.; high abrasion resistance; tensile strength 95-105,000 lbs. per sq. in.; good bearing properties; weldability good; used for parts requiring high strength, good bearing and wearing resistance.

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Grade 20; copper 83.13, aluminum 12.40, iron 4.07, and others 0.4; available as sand and centrifugal castings; corrosion resistant; resists heat to 1000 degrees Fahr.; high abrasion resistance; tensile strength 85,000 lbs. per sq. in.; compressive strength 146,000 lbs. per sq. in.; specific gravity 7.437; good bearing properties; nonmagnetic; brinell hardness, untreated, 241; for use as cams and cam rollers, welding jaws, bushings, bearings, and other wear resistant parts.

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Grade 21; copper 82.34, aluminum 13.02, iron 4.14, others 0.5; available as sand and centrifugal castings; resists heat to 1000 degrees Fahr.; high abrasion resistance; tensile strength, ult., 90,000 lbs. per sq. in.; compressive strength, ult., 160,000 lbs. per sq. in.; ductility, low; specific gravity, 7.152; fair bearing properties; nonmagnetic, brinell hardness, untreated, 311; for use as forming and drawing dies, bushings and bearings replacing hardened steel.

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Grade 22; copper 81.67, aluminum 13.42, iron 4.41, others .50; available as sand and centrifugal castings; resists heat to 1000 degrees Fahr.; high abrasion resistance; tensile strength 90,000 lbs. per sq. in.; compressive strength 171,000 lbs. per sq. in.; low ductility; specific gravity 7.125; fair bearing properties; nonmagnetic; brinell hardness, untreated, 335; for use as forming and drawing dies.

*See advertisement, Page 71-D*

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**AMPCOLOY**—Ampco Metal Inc., Milwaukee. Various grades of copper-base alloys.

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Grade E-1; copper 89, aluminum 10, iron 1; furnished in rough bars or billets, rods or bars, for sand casting, hot forging, extruding, turning, boring, and as centrifugal castings. Resists corrosion caused by acids and other corrosives; resists heat to 1000 degrees Fahr.; medium abrasion resistant; tensile strength, ult., 70,000 to 80,000 lbs. per sq. in.; compressive strength, ult., 136,000 lbs. per sq. in.; ductility, high; specific gravity, 7.48; bearing properties, good; nonmagnetic; used for gears, pickling equipment, bearings, screw down nuts.

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Grade E-123; same analysis as E-1; furnished in rough bars or billets and finished rods and bars, for sand casting, hot forging, turning, boring, and as centrifugal castings. Resists heat to 1000 degrees Fahr.; medium abrasion resistant; tensile strength, ult., 90,000 lbs. per sq. in.; compressive strength, ult., 145,000 lbs. per sq. in.; ductility, medium; specific gravity, 7.48; bearing properties, good; nonmagnetic; weldability, fair; for gears, worm wheels, nuts and bearings.

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Grade A-3; same analysis as E-1; furnished in rough bars or billets, finished rods or bars and plates, for sand casting, hot forging, turning, boring, and as centrifugal castings. Resists corrosion caused by acids and other corrosives; resists heat to 1000 degrees Fahr.; medium abrasion resistant; tensile strength, 75,000 lbs. per sq. in.; compressive strength, ult., 135,000 lbs. per sq. in.; ductility, high; bearing properties, good; nonmagnetic; weldability. good; brinell hardness, untreated, 120; for gears, forgings, bushings, bearings, and pressure parts. Heat treated will meet Fed. Spec. QQ-B-671 Grade B.

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Grade A-323; same analysis as E-1; furnished in rough bars or billets, finished rods or bars and plates, for sand casting, hot forging, turning, boring, and as centrifugal castings. Resists corrosion caused by mild corrosives; resists heat to 1000 degrees Fahr.; medium abrasion resistant; tensile strength, ult., 85,000 lbs. per sq. in.; compressive strength ult., 136,000 lbs. per sq. in.; ductility, high; specific gravity, 7; bearing properties, good; nonmagnetic; weldability, good; used for gears, bushings, bearings, sleeves and forks.

*See advertisement, Page 71-D*

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**AMPCO-TRODE**—Ampco Metal Inc., Milwaukee. Coated welding rods in the six aluminum bronze alloys listed under Ampco Metal. Used for welded overlays on steel and cast iron for bearing or corrosion resisting purposes or welded fabrication of aluminum bronze or brass sheets and castings.

*See advertisement, Page 71-D*

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**AMSCO**—American Manganese Steel Div., The American Brake Shoe & Foundry Co., Chicago Heights, Ill

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Manganese steel; 10 to 14 manganese, 1 to 1.40 carbon, balance iron; suitable for sand casting; for power shovel dippers and teeth, rock crusher parts, dredge pumps, etc.

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Alloy F-1; 15 to 17 chromium, 34 to 36 nickel; for molten metal and containers, liquid containers, and furnace parts for heat treating, especially under frequent and drastic temperature changes; heat resistant to 2100 degrees Fahr.; creep resistant at high temperatures.

F-3; 27 to 29 chromium, 0 to 3 nickel; for rabble arms and blades, sintering bars, etc.; heat resistant to 1800 degrees Fahr. where temperature changes are not wide and where high unit strength is not essential.

F-5; 17 to 19 chromium, 65 to 68 nickel; furnace conveyor pans, heat treating boxes, enameling fixtures, etc.; similar properties to F-1 and F-6, except tougher and more resistant to temperature fluctuations.

F-6; 12 to 14 chromium, 59 to 62 nickel; for heat treating boxes, retorts, etc.; where temperature changes or uneven heating are severe.

F-8; 20 to 22 chromium, 8 to 10 nickel; for mine water and acid pump parts, marine fittings, chemical mixer and paper mill digester parts. Also resistant to heat up to 1600 degrees Fahr.

F-10; 26 to 28 chromium, 10 to 12 nickel; for heat treating furnace shafts, dampers and valves, cement kiln cooler parts, etc.; creep resistant at high temperatures; where temperature changes are not severe; and where high sulphur fuels are used.

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Nickel-manganese steel; 13 to 15 manganese, .70 to .90 carbon, .95 to 1.20 silicon, 3.50 to 4.50 nickel; welding rod for building up and strength welding of austenitic manganese steel castings.

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No. 459; chromium molybdenum hard alloy welding rod for hard surfacing machinery wearing parts; deposits are 500 to 600 brinell.

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No. 217; chromium-molybdenum-tungsten welding rod for hard facing cast wearing parts; extreme hardness and great wear resistance.

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Dieweld; a chromium-molybdenum welding rod for building up forming dies, cutting tools, punches, shear knives, etc.

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Economy hardface; self-hardening, chromium-molybdenum-high carbon welding rod manufactured bare for oxy-acetylene deposition; used for applications where extreme impact and abrasion are encountered.

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**ANACONDA**—American Brass Co., Waterbury, Conn. Many grades of this alloy, as well as pure copper in various forms under this tradename are available, some of which are listed below.

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Beryllium Copper; copper 97.75, beryllium 2.25, nickel 0.25; abrasion resistant; high tensile strength and ductility; for springs, diaphragms, low duty bushings and bearings.

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"85" Red Brass; copper 85, zinc 15; pipe tube and sheet forms; particularly resistant to salt water corrosion.

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Super-Nickel; copper 70, nickel 30; seamless tubes, sheets and plates; for severe condenser tube service and resistance to salt water corrosion.

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Special Phosphor Bronze; copper 88, tin 4, zinc 4, lead 4; corrosion, heat and abrasion resistant; combines general characteristics of standard phosphor bronze alloys with free cutting qualities of yellow brass.

*See advertisement, Pages 17-D—29-D*

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**ANFRILOY**—Wellman Bronze & Aluminum Co., Cleveland. A copper-lead-tin bearing bronze for high speed, light-duty bearings and for bushings where pressure and thrust are not excessive.

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**ANTIMONIAL ADMIRALTY**—Chase Brass & Copper Co., Waterbury, Conn. Copper 71, tin 1, antimony .04, zinc 27.93. Outstanding for general corrosion resistance and particularly for preventing dezincification. Recommended for condensers in the power plant and oil industries.

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**APOLLO CHROMSTEEL**—Apollo Metal Works, Chicago. Cold-rolled strip, nickel-chrome-plated steel, furnished in sheets and strips for stamping into parts. Resists heat up to 800 degrees Fahr.; abrasion resistance, medium; weldability, fair. Used generally for embellishment.

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**APOLLOY METAL**—Apollo Steel Co., Apollo, Pa. Carbon .06-10, manganese .30-60, sulphur .045 max., phosphorus .04 max., copper .20 per cent min.; in sheets.

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**ARISTOLOY**—Copperweld Steel Co., Glassport, Pa. Full range of S.A.E. alloy steels, also aircraft, and special steels; used for gears, both light and heavy-duty, clutches, shafts and pinions; also in ball and roller bearings and aircraft parts, both for engine and plane use.

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**ARMCO**—American Rolling Mill Co., Middletown, O.

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Stainless steel, grade 18-8 (type 302, 304); 17-7 (type 301); 18-12 Mo. (type 316); 25-12 (type 309); 17 (type 430); 13 (type 410); 19-12 Mo. (type 317); 18-10 Cb. (type 347); and 27 (type 446); these can all be drawn and stamped; all machinable, abrasion resistant and weldable.

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Armco High Tensile; a low alloy, high-strength. Supplied in sheets, strips and plates; suitable for stamping and welding.

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Tran-Cor 58; high silicon steel for distribution transformers. Grade 65; steel sheets with low core loss, for power and distribution transformers. Grade 72; a high silicon steel for large generators and general transformer

Intermediate Transformer; scale-free silicon steel sheet for some transformer and special applications.

Special Electric; scale-free medium steel sheet for a.c. motors and generators.

Electric; special analysis sheet for rotating machines.

Armature; steel sheet for small d.c. motors.

Field Grade; special sheet for intermittent duty fractional horsepower motors.

Radio No. 6; for applications in which superior low induction magnetic characteristics are important. No. 5; for audio transformer cores and other low induction applications. No. 4; good permeability at low induction; for chokes. Nos. 3, 2 and 1; for small transformers.

Ingot Iron; highly refined iron for magnetic cores; supplied in round and flat bar form.

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Armco Ingot Iron; highly refined iron supplied in galvanized sheet for general sheet metal work; also hot rolled annealed and cold rolled sheets, plates and strip.

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Armco Enameling Iron; highly refined iron for enameling purposes; supplied in sheets.

Armco wrought steel wheels; one-wear, two-wear, multiple wear, heat-treated and stress resistant. Long mileage and safety factors; meet all A.A.R. or special specifications. Available from 18 to 48-inch diameters.

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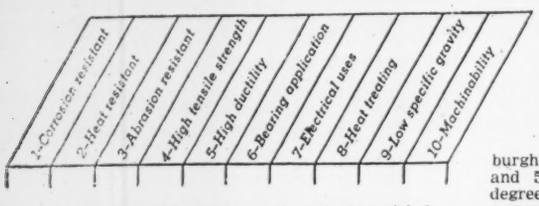
**ASARCOLOY No. 7**—American Smelting & Re-




fining Co., New York. A cadmium-nickel bearing alloy capable of withstanding high compression loads and high operating temperatures. Nickel 1.3, balance cadmium. Furnished in ingots for spinning and permanent mold castings. Resists heat to 300 degrees Fahr.; high abrasion resistance; tensile strength, ult., 15,000 lbs. per sq. in.; compressive strength, ult., 20,000 lbs. per sq. in.; specific gravity, 8.7; bearing properties, good; weldability, good; brinell hardness, untreated 33; used for bearings.

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**ATLAS No. 93**—Allegheny-Ludlum Steel Corp., Pittsburgh Carbon, 55, chromium .65, molybdenum .35; for collets, studs and parts requiring toughness in hardened condition. Oil hardening.

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**AUROMET**—Aurora Metal Co., Aurora, Ill. Special aluminum and silicon bronzes of several compositions.

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**AVIALITE**—American Brass Co., Waterbury, Conn. Copper-aluminum alloy for valve seats and guides in airplane motors.

*See advertisement, Pages 17-D—20-D*

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**"AW" (rolled steel floor plate)**—Alan Wood Steel Co., Conshohocken, Pa. Furnished in five patterns to meet flooring problems in the industrial and transportation fields; designed to withstand heaviest traffic; oilproof, crackproof, heatproof, slipproof, and noiseless. Furnished in carbon, copper or alloy analysis; also available in other nonferrous metals.

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**"AW" DYN-EL**—Alan Wood Steel Co., Conshohocken, Pa. Furnished in sheets, strips, and plates, for stamping, welding, cold forming and hot forming, etc.; abrasion resistance medium; tensile strength 70,000-80,000 lbs. per sq. in.; ductility high; weldability good; fatigue and impact values high; for structures requiring high strength.

## B

1 2 - - - - - - - -

**B & W CROLOY**—Babcock & Wilcox Tube Co., Beaver Falls, Pa.

2; carbon .15 max., chromium 1.75-2.25, molybdenum .45-.65, silicon .50 max.; for refinery and superheater tubes. Corrosion resistant and heat resistant at nominal temperatures.

2¼; carbon .15 max., chromium 2-2.5, molybdenum .9-1.1, silicon .5 max.; for refinery and superheater tubes where exceptionally high creep strength is required.

5; chromium molybdenum; carbon .15 max., chromium 4-6, molybdenum .45-.65; for oil refinery service.

7; carbon .15 max., chromium 6-8, molybdenum .45-.65 for oil refinery service where increased corrosion resistance is required.

9; carbon .15 max., chromium 8-10, molybdenum 1.2 min.; semistainless alloy of good physical properties and corrosion resistance.

12 (type 410); carbon .15 max., chromium 12-14; resistant to atmosphere and acids; resists heat to 1500 degrees Fahr. and when heat treated has tensile strength of 180,000 lbs. per sq. in.

18 (type 430); carbon .12 max., chromium 15-18; useful for certain elevated temperature applications but particularly for nitric acid plant equipment.

18-8S (type 304); carbon .08 max., chromium 18-20, nickel 8-11; low carbon; for high temperature work or corrosion resistant service.

16-13-3 (type 316); carbon .10 max., manganese 2 max., chromium 16-18, nickel 11-14; molybdenum 2-3; austenitic type alloy similar in many respects to 18-8s and 25-20; high strength at elevated temperatures; corrosion resistant.

25-20 (type 310); chromium 25, nickel 20; high strength and high oxidation resistance; also excellent corrosion resistance.

27 (type 446); carbon .2 max., chromium 26-30, resistant to oxidation to 2100 degrees Fahr.; also corrosion resistant.

*See advertisement, Page 65-D*

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**BAKER**—Baker & Co. Inc., Newark, N. J. Platinum and alloys for linings, contacts, thermocouples, furnace resistors, etc.

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**BEARITE**—A. W. Cadman Mfg. Co., Pittsburgh; babbitt metal furnished in ingots and 50-pound pigs; brinell hardness at 70 degrees Fahr. 29.1, 212 degrees Fahr. 24.4; compressive strength 15,000 lbs. per sq. in.; for rotary bearings subjected to heavy loads and extreme speed.

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**BECKETT METAL**—Beckett Bronze Co., Muncie, Ind. Several grades of high lead bronze; copper 60 to 75, tin 3 to 9, lead 16 to 35, and nickel 0 to 1; furnished in rough bars and rods (cored or solid) for turning, boring, etc.; resists corrosion due to sulphuric-hydrochloric acid solutions, and resistant to heat to 400 deg. Fahr.; tensile strength 21,000 to 24,000 lbs. per sq. in.; good bearing properties; brinell hardness, untreated, 36 to 46; used for bearings, bushings, and to a limited extent in seals, piston rings and gears.

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**BELECTRIC**—Belle City Malleable Iron Co., Racine, Wis. Furnished as sand castings; tensile strength 35,000-60,000 lbs. per sq. in.; high compressive strength; good bearing properties; recommended heat treatments are the same as for standard gray iron; brinell hardness, untreated 179-285, heat treated 300-550; used where rigidity, wearability or where strong high grade gray iron might be applied.

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**BELECTROMAL**—Belle City Malleable Iron Co., Racine, Wis. High strength malleable iron furnished as sand castings; tensile strength 60,000-70,000 lbs. per sq. in.; high ductility; brinell hardness, untreated 140-170; recommended for castings for automotive, railroad tractor and implement work.

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**BELMALLOY**—Belle City Malleable Iron Co., Racine, Wis. Pearlitic malleable iron, electric furnace melted and continuous oven annealed; for castings of machining quality requiring strength and shock resistance.

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**BERMAX BABBITT**—Federal Mogul Corp., Detroit. A high lead babbitt; easy to use, cast and easy to handle in rebabbitting; melting point slightly higher than that of tin-base metals and can be cast by any method without fear of segregation; for use as bearing lining.

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**BETHADUR**—Bethlehem Steel Co., Bethlehem, Pa. Steels of the designated characteristics for virtually all purposes except those calling for free machining. This tradename covers 43 different corrosion resistant alloying steels adaptable for machinery in the chemical industries, oil refining, mining and metallurgy, the paper industry, the food industry, etc. The following are typical examples:

No. 302; 18-20 chromium, 8-10 nickel, .08-.20 carbon.

No. 304; 18-20 chromium, 8-10 nickel, .08 max. carbon.

No. 308; 19-22 chromium, 10-12 nickel, .08 max. carbon.

No. 403; 11.5-13 chromium, .15 max. carbon (turbine blading).

No. 410; 10-13.5 chromium, .15 max. carbon.

No. 420; 12-14 chromium, .15 min. carbon.

No. 430; 14-18 chromium, .12 max. carbon.

No. 440; 14-18 chromium, .12 min. carbon.

No. 442; 18-23 chromium, .35 max. carbon.

No. 446; 23-30 chromium, .35 max. carbon.

No. 501; 4-6 chromium, .10 min. carbon.

No. 502; 4-6 chromium, .10 max. carbon.

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**BETHALON**—Bethlehem Steel Co., Bethlehem, Pa. Free-machining, high chromium steel for variety of machine parts. Two typical grades are the following:

No. 303; 18-20 chromium, 8-10 nickel, .20 max. carbon, .15 min. or .60 max. sulphur or selenium.

No. 416; 12-14 chromium, .12 max. carbon, .15 min. or .60 max. sulphur or selenium.

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**BETH-CU-LOY**—Bethlehem Steel Co., Bethlehem, Pa. A copper bearing steel resistant to atmospheric corrosion; for jackets, covers, machine guards, oil pans, etc.

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**BETHLEHEM**—Bethlehem Steel Co., Bethlehem, Pa.

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Nos. 235 and 300; abrasion resistant, high-carbon-manganese-silicon steels of 235 and 300 brinell respectively; for shovels, crushers, hoppers, scraper blades and conveyors.

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Nos. 6 and 7; nickel steels containing 35 and 40 per cent nickel respectively; have low coefficient of expansion; for scientific and measuring instruments and for control equipment.

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**BETHLEHEM**—Bethlehem Steel Co., Bethlehem, Pa.

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Bearing steels; high carbon steels in three grades, namely; "Standard" chromium steel, "H. T. W." chromium-vanadium steel, and "Moly" chromium-molybdenum steel. All grades are processed to meet requirements of bearings for automotive and industrial service. Other uses include injector parts for diesel engines.

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Magnet steels; high carbon steels with varying chromium content, up to 6 per cent. Permanent magnet No. 1, a 6 per cent tungsten steel; Cobaflux, a high cobalt steel used for magnets in meters, telephones, magnetos and other electrical equipment.

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**BETHLEHEM 88-80**—Bethlehem Steel Co., Bethlehem, Pa. Chromium molybdenum steel castings with high abrasion resistance for ball mill liners, rolls, tires, bottom plates, etc.

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**BIRDSBORO**—Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.

No. 26; high physical properties including high tensile strength; resists corrosion because of copper content; for dredge castings and other castings subject to high stress.

No. 30; resists corrosion due to its copper and molybdenum content; recommended for dredge castings and other castings subject to high stress.

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**BISHOP STAINLESS**—J. Bishop & Co. Platinum Works, Malvern, Pa. A stainless steel seamless tubing; heat and corrosion resistant; furnished in a large number of diameter and gage combinations. Mechanical tubing class comprises large group of sizes and uses, from tiny tubing 1/100 in. outside diameter for fine instruments to ¾-inch, ⅞ or 1-inch sizes for condensers, dairy equipment, heat exchangers, chemical plant equipment etc. Capillary tubing has very small bore in relation to outside diameter, produced in long lengths and in a variety of sizes. Hypodermic needle tubing; available in range from 33 to 11 Stubbs gage having appropriate wall thickness and held within close tolerances.

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**BLACKSKIN ADMIRALTY, Bulldog Brand**—Phelps Dodge Copper Products Corp., New York. Copper 70, zinc 29, tin 1; furnished in tubing, sheets and strips for extruding, welding and drawing; corrosion resistant; resists heat to 450 degrees Fahr.; tensile strength 45,000-60,000 lbs. per sq. in.; high ductility; for condenser tubes.

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**BOHNALITE**—Bohn Aluminum & Brass Corp., Detroit. Light alloy of which aluminum is the base; for forged connecting rods, cast cylinder heads, crankcases, transmission cases, and parts for vacuum cleaners, washing machines, shoe machinery, etc.

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**BORIUM**—Stoody Co., Whittier, Calif. Tungsten carbide metal used chiefly as inserts in rotary drilling tools as substitute for diamonds. Tube Borium and Borod; made up of steel tubing containing fine particles of Borium; used as overlays on earth working equipment.

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**BOUND BROOK**—Bound Brook Oil-less Bearing Co., Bound Brook, N. J. Bushings, bearings and washers; cast phosphor bronze inlaid with hard graphite lubricant in grooves or holes of various designs; particularly adaptable to high temperatures, severe static loads, immersion in liquids, exposure to dusts or where oils are objectionable.

*See advertisement, Page 81-D*

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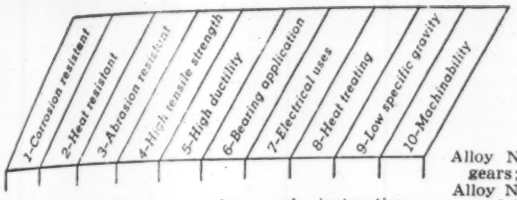
**BRASSOID**—American Nickeloid Co., Peru, Ill. Brass bonded to zinc, latter serving as rustproof, flexible and inexpensive white metal base. Available in variety of brilliant finishes and patterns, as sheets, flat strips and coiled strip for continuous feed automatic presses. Can be supplied with quick removable, gum adhered paper covering permitting drawing and forming without marring pre-finish. For toys, machinery trim




and nameplates, index and instruction plates, etc.

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**BRIDGEPORT COPPER AND ZINC ALLOYS**—Bridgeport Brass Co., Bridgeport, Conn.

Yellow brass; copper 65, zinc, 35, copper 70, zinc 30; sheet, wire and seamless tubing for drawing, stampings, and cold heading.

Free cutting brass rod; copper 60, lead 3, balance zinc; for making automatic screw machine parts.

Forging rod-copper 60, lead 2.

Low brass; copper 80, zinc 20; pale golden color; for articles requiring greater ductility and malleability than possessed by yellow brass.

Commercial bronze; copper 90, zinc 10; bronze color for manufacturing stampings and drawn items and cold headed items, for outdoor use; stands weathering better than yellow brass; copper sheet, rod, wire, seamless tubing for miscellaneous manufacturing. Leaded brass alloys, containing from ¼-3.75 per cent lead to facilitate machining.

Phosphor bronze; copper 92, tin 8; for spring parts; has better spring properties than lower tin content.

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Phosphor bronze; copper 95, tin 5; sheet spring quality for manufacturing switch parts.

Copper in form of sheet and tube for fabricating.

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**BRIDGEPORT TUBING**—Bridgeport Brass Co., Bridgeport, Conn.

Condenser tubing; Available in Admiralty metal for sea water, Cuzinal (aluminum brass) for harbor water, Muntz metal for fresh water, Duronze IV for aerated harbor water, Cupro-Nickel for most severe service and U. S. Navy requirements, and Arsenical copper for resisting corrosion better than straight copper.

Duplex tubing; for two different types of corrosion inside and outside of tubing which are too severe for a single alloy. Steel, stainless steel, aluminum on either side or inside in combination with Admiralty brass, aluminum brass, copper or cupro nickel, used for oil refining, refrigeration systems, chemical plants and food processing.

Copper water tubing; for industrial applications.

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**BUFFALO Wire Cloth**—Buffalo Wire Works Co. Inc., Buffalo, N. Y. Wire cloth for every industrial use; screens for abrasive material, chemicals and powder in plain steel, tinned, brass, copper, bronze, monel and stainless steel; also galvanized after woven wire cloth.

*See advertisement, Page 83-D*

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**BUFLOKAST**—Buffalo Foundry & Machine Co., Buffalo. Silicon 1 to 2, sulphur .07-.12, phosphorus .10-.40, manganese .60-1.25, carbon 2.90-3.80, nickel .50-3, chromium .5-2, molybdenum .5-1.50; furnished as sand castings; resists corrosion due to acids and alkalies; resists heat to 1800 degrees Fahr.; medium abrasion resistance; tensile strength ult., 30,000-60,000 lbs. per sq. in.; for chemical and vacuum drying machinery.

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**BULLDOG BRAND**—Phelps Dodge Copper Products Corp., New York.

Aluminum Brass (Bulldog Brand); copper 76, tin 22, aluminum 2; furnished in tubing for extruding, welding and drawing; corrosion resistant; resists heat to 406 degrees Fahr.; tensile strength 50,000-83,000 lbs. per sq. in.; high ductility; for condenser tubes.

Arsenical Copper (Bulldog Brand); copper 99.7, arsenic .3 (nominal); furnished as tubing; for hot forging, stamping, extruding, welding, drawing, turning, boring, etc.; resists heat to 406 degrees Fahr.; tensile strength 36,000-60,000 lbs. per sq. in.; high ductility; for condenser tubes and heat exchanger tubes.

Copper nickel; copper 70; nickel 30; for extruding and drawing; corrosion resistant; heat resistant to 550 degrees Fahr.; tensile strength, ult., 49,000-84,000 lbs. per sq. in.; ductility, high; used for condenser tubes and heat exchangers.

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**BUNTING**—Bunting Brass & Bronze Co., Toledo. A line of some 160 bearing bronzes available as fully-machined bar stock and ready-cut bushings, including the following:

Alloy No. 27; phosphor bronze (leaded) for bearings.

Alloy No. 51; for low speeds, heavy loads, gears; free-machining.

Alloy No. 72; general purpose bearing bronze; used in standard stock items.

Alloy No. 96; high strength, excellent machinability, low speeds, heavy loads.

Alloy No. 124; camshaft bearings, piston pin bearings, etc.

Alloy No. 125; high lead, low friction, scanty lubrication applications.

Alloy No. 135; for average bushing applications.

Alloy No. 156; hard gear bronze.

Alloy No. 164; nickel gear bronze, synchronizer cones.

Alloy No. 178; copper-lead precision type main and connecting rod bearings.

Babbitt; genuine babbitt, lead base babbitt.

Precision; cored and solid fully-machined bar stock from dense grained bearing bronze.

*See advertisement, Page 6-D*

## C

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**CMP STRIP**—The Cold Metal Process Co., Youngstown, O. Precision cold rolled strip steel, of carbon and alloy steels. Has regular finish, bright mirror finish (one or two sides), blued finish (both sides) and sandblasted finish (one or two sides).

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**CANNON 3½ PER CENT NICKEL STEEL**—Cannon-Stein Steel Corp., Syracuse, N. Y.

S.A.E. 2315; carbon .15, manganese .45, phosphorus .04, sulphur .05, silicon .30, nickel .35; brinell hardness untreated 174; recommended heat treatment carburized at 1650 degrees Fahr., heat treated at 1450-1500 degrees Fahr. oil quenched. Resists corrosion due to nickel content; resists heat to 800-1000 degrees Fahr.; tensile strength 85,000 lbs. per sq. in. as rolled; for king pins, rock drill parts, air hammer parts, universal joints, bolts, shafts, studs, etc.

S.A.E. 2320; carbon .20, manganese .50, phosphorus .04, sulphur .05, silicon .03 max., nickel 3.50; brinell hardness untreated 174; recommended heat treatment carburized at 1650 degrees Fahr., heat treated at 1450-1500 degrees Fahr.; resists corrosion due to nickel content; resists heat to 800-1000 degrees Fahr.; tensile strength 90,000 lbs. per sq. in. as rolled; for uses same as S.A.E. 2315.

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**CARBOLOY**—Carboloy Co. Inc., Detroit. A series of cemented carbides basically made from tungsten carbide and a softer cementing element such as cobalt. In certain grades, supplementary ingredients are the carbides of tantalum, titanium or other metals. Has high resistance to abrasive and corrosive wear; outstanding on account of its extreme hardness, compressive strength being as high as 800,000 lbs. per sq. in.; Rockwell hardness on "A" scale 86-93; does not rust or corrode under normal conditions. Recommended as wear resistant inserts for machine parts subject to extreme wear such as cams, cam followers, hydraulic valve stems and seats, machine tool rests, etc.

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**CARBOMANG**—Detroit Alloy Steel Co., Detroit. Furnished as castings. Carbon .90-1.00, manganese 1.00-1.10, chromium .40-.60; medium abrasion; tensile strength, ult., 125,000 lbs. per sq. in.; compressive strength, ult., 200,000 lbs. per sq. in.; medium ductility; brinell hardness, untreated 200, heat treated 600; for air-hardening tool steel castings.

1 2 3 4 5 6 7 - - -

**CARPENTER**—The Carpenter Steel Co., Reading, Pa.

1 2 - 4 - - - - - - -

Stainless No. 3; chromium 20, copper 1; for special chemical apparatus and scale resisting parts.

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Stainless No. 2; carbon .3; chromium 13; used in fully hardened condition for ball bearings, ball check valves, cutlery, instruments, etc.

Stainless No. 2B; carbon 1, chromium 17; uses same as No. 2.

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Stainless No. 3; chromium 20, copper 1; for special chemical apparatus and scale resisting parts.

1 2 - 4 - - - - - - -

Stainless No. 4; carbon .1, chromium 18, nickel 8; for rolled moldings, stampings, etc.; also has high ductility.

Stainless No. 5; carbon .1, chromium 14, sulphur .30; a free machining grade for automatic screw machine parts, valve trim, pump shafts, etc. Is heat resistant.

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Stainless No. 6; carbon .1, chromium 16 to 18; uses same as No. 1 and No. 4.

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Stainless No. 8; carbon .1, chromium 18, nickel 8, selenium .25; a free machining grade; heat resistant.

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Chrome magnet steel; carbon .95, chromium 3.5; for magnets in meters and other electrical apparatus.

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Presto; carbon 1.05, chromium 1.4; for ball and roller bearings.

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Silico-manganese steel; carbon .6, manganese .75, silicon 2; for heavy duty springs.

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No. 5-317; chrome nickel steel; carbon .5, nickel 1.75, chromium 1; for gears, clutches and shafts.

No. 5 Samson; carbon .5, nickel 1.25, chromium .6; for gears and clutches.

No. 4-408; carbon .4, nickel 3, chromium .75; for clutches and shafts.

- - 3 4 5 - - - - - -

No. 158; carbon .1, nickel 3.5, chromium 1.5; for case hardened high duty clash gears, shafts, clutch parts.

- - 3 4 - - - - - - -

No. 4 Samson steel; carbon .4, nickel 1.25, chromium .6; for side links of silent chains, shafts, axles, etc.

- - 3 - 5 - - - - - -

No. 2 Samson; carbon .2, nickel 1.25, chromium .6; for case-hardened gears, roller bearings, pneumatic tool parts, etc.

- - 3 4 - - - - - - -

No. 3-547; nickel steel; carbon .3, nickel 3.5; for heat treated shafts, etc.

- - 3 - 5 - - - - - -

No. 2-547; case hardening nickel steel; carbon .2, nickel 3.5; for small parts requiring hard surface and tough core.

No. 500; carbon .1, nickel 5; for turbine blades, case-hardened gears, etc.

- - 3 4 - - - - - - -

Chrome vanadium 5-720; carbon 5, chromium .9, vanadium .2; for leaf and coil springs, gears, shafts, etc.

No. 3-427 chrome molybdenum steel; carbon .3, chromium 1, molybdenum .2; for aircraft and automotive parts.

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No. 436; carbon .15, nickel 1.75, molybdenum .25; for case-hardened parts.

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Temperature compensator alloy; iron-nickel alloy; furnished in rough bars or billets, finished rods or bars, wire and strips for hot forging, stamping, turning, boring, etc.; permeability varies inversely as temperature; for magnetic shunts for meters, speedometers, tachometers, voltage regulators, etc.

*See advertisement, Page 91-D*

- - 3 4 - - - 8 - -

**CAST ALLOY STEEL**—The Alloy Cast Steel Co., Marion, O.

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Nickel steel castings; carbon .30-.40, manganese .60-.80, sulphur .05 max., phosphorus .045 max., silicon .35-.45, nickel 3.25-3.75; has high strength and resistance to shock and fatigue; used largely in annealed condition, although responds to heat treatment.

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Nickel chrome steel castings; carbon .35-.45, manganese .60-.80, phosphorus .045 max., sulphur .05 max., silicon .35-.45, nickel 1.50-2.00, chromium .60-.75; has high strength and wear resistance.

- - 3 4 - - - 8 - -

Nickel, chrome, molybdenum steel castings; carbon .35-.45, manganese .60-.80, phosphorus .045 max., sulphur .050 max., silicon .35-.45, nickel 1.50-2.00, chrome .60-.75, molybdenum .25-.45; used in parts which must be strong and hard and where size or shape prevent liquid quenching.

- - 3 4 - - - 8 - -

Manganese molybdenum steel castings; carbon .30-.40, manganese 1.25-1.60, phosphorus .045 max., sulphur .050 max., silicon .35-.45, molybdenum .25-.45; used for gears, sprockets, levers, etc.

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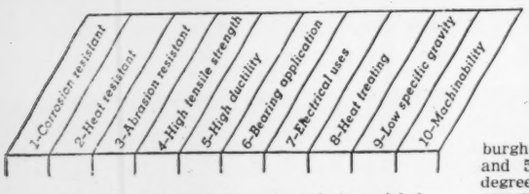
Medium manganese steel castings; carbon .30-.40, manganese 1.25-1.50, phosphorus .045 max., sulphur .050 max., silicon .35-.45; used in power shovels, tractors, road machinery, etc.

High manganese steel castings; carbon 1.10-1.30, manganese 10.50-13.50, phosphorus .10




fining Co., New York. A cadmium-nickel bearing alloy capable of withstanding high compression loads and high operating temperatures. Nickel 1.3, balance cadmium. Furnished in ingots for spinning and permanent mold castings. Resists heat to 300 degrees Fahr.; high abrasion resistance; tensile strength, ult., 15,000 lbs. per sq. in.; compressive strength, ult., 20,000 lbs. per sq. in.; specific gravity, 8.7; bearing properties, good; weldability, good; brinell hardness, untreated 33; used for bearings.

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**ATLAS No. 93**—Allegheny-Ludlum Steel Corp., Pittsburgh Carbon, 55, chromium .65, molybdenum .35; for collets, studs and parts requiring toughness in hardened condition. Oil hardening.

1 2 - 4 - - - - - - -

**AUROMET**—Aurora Metal Co., Aurora, Ill. Special aluminum and silicon bronzes of several compositions.

1 2 3 - - - - - - - -

**AVIALITE**—American Brass Co., Waterbury, Conn. Copper-aluminum alloy for valve seats and guides in airplane motors.
*See advertisement, Pages 17-D—20-D*

\- 2 - - - - - - - -

**"AW" (rolled steel floor plate)**—Alan Wood Steel Co., Conshohocken, Pa. Furnished in five patterns to meet flooring problems in the industrial and transportation fields; designed to withstand heaviest traffic; oilproof, crackproof, heatproof, slipproof, and noiseless. Furnished in carbon, copper or alloy analysis; also available in other nonferrous metals.

1 - - 4 - - - - - -

**"AW" DYN-EL**—Alan Wood Steel Co., Conshohocken, Pa. Furnished in sheets, strips, and plates, for stamping, welding, cold forming and hot forming, etc.; abrasion resistance medium; tensile strength 70,000-80,000 lbs. per sq. in.; ductility high; weldability good; fatigue and impact values high; for structures requiring high strength.

## B

1 2 - - - - - - - - -

**B & W CROLOY**—Babcock & Wilcox Tube Co., Beaver Falls, Pa.
2; carbon .15 max., chromium 1.75-2.25, molybdenum .45-.65, silicon .50 max.; for refinery and superheater tubes. Corrosion resistant and heat resistant at nominal temperatures.
2¼; carbon .15 max., chromium 2-2.5, molybdenum .9-1.1, silicon .5 max.; for refinery and superheater tubes where exceptionally high creep strength is required.
5; chromium molybdenum; carbon .15 max., chromium 4-6, molybdenum .45-.65; for oil refinery service.
7; carbon .15 max., chromium 6-8, molybdenum .45-.65 for oil refinery service where increased corrosion resistance is required.
9; carbon .15 max., chromium 8-10, molybdenum 1.2 min.; semistainless alloy of good physical properties and corrosion resistance.
12 (type 410); carbon .15 max., chromium 12-14; resistant to atmosphere and acids; resists heat to 1500 degrees Fahr. and when heat treated has tensile strength of 180,000 lbs. per sq. in.
18 (type 430); carbon .12 max., chromium 15-18; useful for certain elevated temperature applications but particularly for nitric acid plant equipment.
18-8S (type 304); carbon .08 max., chromium 18-20, nickel 8-11; low carbon; for high temperature work or corrosion resistant service.
16-13-3 (type 316); carbon .10 max., manganese 2 max., chromium 16-18, nickel 11-14; molybdenum 2-3; austenitic type alloy similar in many respects to 18-8s and 25-20; high strength at elevated temperatures; corrosion resistant.
25-20 (type 310); chromium 25, nickel 20; high strength and high oxidation resistance; also excellent corrosion resistance.
27 (type 446); carbon .2 max., chromium 26-30, resistant to oxidation to 2100 degrees Fahr.; also corrosion resistant.
*See advertisement, Page 65-D*

1 2 - - - - 7 - - -

**BAKER**—Baker & Co. Inc., Newark, N. J. Platinum and alloys for linings, contacts, thermocouples, furnace resistors, etc.

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**BEARITE**—A. W. Cadman Mfg. Co., Pittsburgh; babbitt metal furnished in ingots and 50-pound pigs; brinell hardness at 70 degrees Fahr. 29.1, 212 degrees Fahr. 24.4; compressive strength 15,000 lbs. per sq. in.; for rotary bearings subjected to heavy loads and extreme speed.

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**BECKETT METAL**—Beckett Bronze Co., Muncie, Ind. Several grades of high lead bronze; copper 60 to 75, tin 3 to 9, lead 16 to 35, and nickel 0 to 1; furnished in rough bars and rods (cored or solid) for turning, boring, etc.; resists corrosion due to sulphuric-hydrochloric acid solutions, and resistant to heat to 400 deg. Fahr.; tensile strength 21,000 to 24,000 lbs. per sq. in.; good bearing properties; brinell hardness, untreated, 36 to 46; used for bearings, bushings, and to a limited extent in seals, piston rings and gears.

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**BELECTRIC**—Belle City Malleable Iron Co., Racine, Wis. Furnished as sand castings; tensile strength 35,000-60,000 lbs. per sq. in.; high compressive strength; good bearing properties; recommended heat treatments are the same as for standard gray iron; brinell hardness, untreated 179-285, heat treated 300-550; used where rigidity, wearability or where strong high grade gray iron might be applied.

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**BELECTROMAL**—Belle City Malleable Iron Co., Racine, Wis. High strength malleable iron furnished as sand castings; tensile strength 60,000-70,000 lbs. per sq. in.; high ductility; brinell hardness, untreated 140-170; recommended for castings for automotive, railroad tractor and implement work.

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**BELMALLOY**—Belle City Malleable Iron Co., Racine, Wis. Pearlitic malleable iron, electric furnace melted and continuous oven annealed; for castings of machining quality requiring strength and shock resistance.

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**BERMAX BABBITT**—Federal Mogul Corp., Detroit. A high lead babbitt; easy to use, cast and easy to handle in rebabbitting; melting point slightly higher than that of tin-base metals and can be cast by any method without fear of segregation; for use as bearing lining.

1 2 - - - - - - - - -

**BETHADUR**—Bethlehem Steel Co., Bethlehem, Pa. Steels of the designated characteristics for virtually all purposes except those calling for free machining. This tradename covers 43 different corrosion resistant alloying steels adaptable for machinery in the chemical industries, oil refining, mining and metallurgy, the paper industry, the food industry, etc. The following are typical examples:
No. 302; 18-20 chromium, 8-10 nickel, .08-.20 carbon.
No. 304; 18-20 chromium, 8-10 nickel, .08 max. carbon.
No. 308; 19-22 chromium, 10-12 nickel, .08 max. carbon.
No. 403; 11.5-13 chromium, .15 max. carbon (turbine blading).
No. 410; 10-13.5 chromium, .15 max. carbon.
No. 420; 12-14 chromium, .15 min. carbon.
No. 430; 14-18 chromium, .12 max. carbon.
No. 440; 14-18 chromium, .12 min. carbon.
No. 442; 18-23 chromium, .35 max. carbon.
No. 446; 23-30 chromium, .35 max. carbon.
No. 501; 4-6 chromium, .10 min. carbon.
No. 502; 4-6 chromium, .10 max. carbon.

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**BETHALON**—Bethlehem Steel Co., Bethlehem, Pa. Free-machining, high chromium steel for variety of machine parts. Two typical grades are the following:
No. 303; 18-20 chromium, 8-10 nickel, .20 max. carbon, .15 min. or .60 max. sulphur or selenium.
No. 416; 12-14 chromium, .12 max. carbon, .15 min. or .60 max. sulphur or selenium.

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**BETH-CU-LOY**—Bethlehem Steel Co., Bethlehem, Pa. A copper bearing steel resistant to atmospheric corrosion; for jackets, covers, machine guards, oil pans, etc.

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**BETHLEHEM**—Bethlehem Steel Co., Bethlehem, Pa.

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Nos. 235 and 300; abrasion resistant, high-carbon-manganese-silicon steels of 235 and 300 brinell respectively; for shovels, crushers, hoppers, scraper blades and conveyors.

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Nos. 6 and 7; nickel steels containing 35 and 40 per cent nickel respectively; have low coefficient of expansion; for scientific and measuring instruments and for control equipment.

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**BETHLEHEM**—Bethlehem Steel Co., Bethlehem, Pa.

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Bearing steels; high carbon steels in three grades, namely; "Standard" chromium steel, "H. T. W." chromium-vanadium steel, and "Moly" chromium-molybdenum steel. All grades are processed to meet requirements of bearings for automotive and industrial service. Other uses include injector parts for diesel engines.

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Magnet steels; high carbon steels with varying chromium content, up to 6 per cent. Permanent magnet No. 1, a 6 per cent tungsten steel; Cobaflux, a high cobalt steel used for magnets in meters, telephones, magnetos and other electrical equipment.

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**BETHLEHEM 88-80**—Bethlehem Steel Co., Bethlehem, Pa. Chromium molybdenum steel castings with high abrasion resistance for ball mill liners, rolls, tires, bottom plates, etc.

1 2 - - 4 - - - - - -

**BIRDSBORO**—Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.
No. 26; high physical properties including high tensile strength; resists corrosion because of copper content; for dredge castings and other castings subject to high stress.
No. 30; resists corrosion due to its copper and molybdenum content; recommended for dredge castings and other castings subject to high stress.

1 2 - - - - - - - - -

**BISHOP STAINLESS**—J. Bishop & Co. Platinum Works, Malvern, Pa. A stainless steel seamless tubing; heat and corrosion resistant; furnished in a large number of diameter and gage combinations. Mechanical tubing class comprises large group of sizes and uses, from tiny tubing 1/100 in. outside diameter for fine instruments to ¾-inch, ⅞ or 1-inch sizes for condensers, dairy equipment, heat exchangers, chemical plant equipment etc. Capillary tubing has very small bore in relation to outside diameter, produced in long lengths and in a variety of sizes. Hypodermic needle tubing; available in range from 33 to 11 Stubbs gage having appropriate wall thickness and held within close tolerances.

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**BLACKSKIN ADMIRALTY, Bulldog Brand**—Phelps Dodge Copper Products Corp., New York. Copper 70, zinc 29, tin 1; furnished in tubing, sheets and strips for extruding, welding and drawing; corrosion resistant; resists heat to 450 degrees Fahr.; tensile strength 45,000-60,000 lbs. per sq. in.; high ductility; for condenser tubes.

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**BOHNALITE**—Bohn Aluminum & Brass Corp., Detroit. Light alloy of which aluminum is the base; for forged connecting rods, cast cylinder heads, crankcases, transmission cases, and parts for vacuum cleaners, washing machines, shoe machinery, etc.

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**BORIUM**—Stoody Co., Whittier, Calif. Tungsten carbide metal used chiefly as inserts in rotary drilling tools as substitute for diamonds. Tube Borium and Borod; made up of steel tubing containing fine particles of Borium; used as overlays on earth working equipment.

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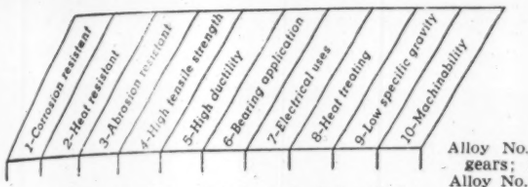
**BOUND BROOK**—Bound Brook Oil-less Bearing Co., Bound Brook, N. J. Bushings, bearings and washers; cast phosphor bronze inlaid with hard graphite lubricant in grooves or holes of various designs; particularly adaptable to high temperatures, severe static loads, immersion in liquids, exposure to dusts or where oils are objectionable.
*See advertisement, Page 81-D*

1 - - - 5 - - - - -

**BRASSOID**—American Nickeloid Co., Peru, Ill. Brass bonded to zinc, latter serving as rustproof, flexible and inexpensive white metal base. Available in variety of brilliant finishes and patterns, as sheets, flat strips and coiled strip for continuous feed automatic presses. Can be supplied with quick removable, gum adhered paper covering permitting drawing and forming without marring pre-finish. For toys, machinery trim




and nameplates, index and instruction plates, etc.

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**BRIDGEPORT COPPER AND ZINC ALLOYS**—Bridgeport Brass Co., Bridgeport, Conn.

Yellow brass; copper 65, zinc, 35, copper 70, zinc 30; sheet, wire and seamless tubing for drawing, stampings, and cold heading.

Free cutting brass rod; copper 60, lead 3, balance zinc; for making automatic screw machine parts.

Forging rod-copper 60, lead 2.

Low brass; copper 80, zinc 20; pale golden color; for articles requiring greater ductility and malleability than possessed by yellow brass.

Commercial bronze; copper 90, zinc 10; bronze color for manufacturing stampings and drawn items and cold headed items, for outdoor use; stands weathering better than yellow brass; copper sheet, rod, wire, seamless tubing for miscellaneous manufacturing. Leaded brass alloys, containing from ¼-3.75 per cent lead to facilitate machining.

Phosphor bronze; copper 92, tin 8; for spring parts; has better spring properties than lower tin content.

1 - - 4 - - - - - - -

Phosphor bronze; copper 95, tin 5; sheet spring quality for manufacturing switch parts.

Copper in form of sheet and tube for fabricating.

1 2 - - 5 - - - - - -

**BRIDGEPORT TUBING**—Bridgeport Brass Co., Bridgeport, Conn.

Condenser tubing; Available in Admiralty metal for sea water, Cuzinal (aluminum brass) for harbor water, Muntz metal for fresh water, Duronze IV for aerated harbor water, Cupro-Nickel for most severe service and U. S. Navy requirements, and Arsenical copper for resisting corrosion better than straight copper.

Duplex tubing; for two different types of corrosion inside and outside of tubing which are too severe for a single alloy. Steel, stainless steel, aluminum on either side or inside in combination with Admiralty brass, aluminum brass, copper or cupro nickel, used for oil refining, refrigeration systems, chemical plants and food processing.

Copper water tubing; for industrial applications.

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**BUFFALO Wire Cloth**—Buffalo Wire Works Co. Inc., Buffalo, N. Y. Wire cloth for every industrial use; screens for abrasive material, chemicals and powder in plain steel, tinned, brass, copper, bronze, monel and stainless steel; also galvanized after woven wire cloth.

***See advertisement, Page 83-D***

1 2 - 4 - - - - - - -

**BUFLOKAST**—Buffalo Foundry & Machine Co., Buffalo. Silicon 1 to 2, sulphur .07-.12, phosphorus .10-.40, manganese .60-1.25, carbon 2.90-3.80, nickel .50-3, chromium .5-2, molybdenum .5-1.50; furnished as sand castings; resists corrosion due to acids and alkalies; resists heat to 1800 degrees Fahr.; medium abrasion resistance; tensile strength ult., 30,000-60,000 lbs. per sq. in.; for chemical and vacuum drying machinery.

1 2 - - 5 - - - - - -

**BULLDOG BRAND**—Phelps Dodge Copper Products Corp., New York.

Aluminum Brass (Bulldog Brand); copper 76, tin 22, aluminum 2; furnished in tubing for extruding, welding and drawing; corrosion resistant; resists heat to 406 degrees Fahr.; tensile strength 50,000-83,000 lbs. per sq. in.; high ductility; for condenser tubes.

Arsenical Copper (Bulldog Brand); copper 99.7, arsenic .3 (nominal); furnished as tubing; for hot forging, stamping, extruding, welding, drawing, turning, boring, etc.; resists heat to 406 degrees Fahr.; tensile strength 36,000-60,000 lbs. per sq. in.; high ductility; for condenser tubes and heat exchanger tubes.

Copper nickel; copper 70; nickel 30; for extruding and drawing; corrosion resistant; heat resistant to 550 degrees Fahr.; tensile strength, ult., 49,000-84,000 lbs. per sq. in.; ductility, high; used for condenser tubes and heat exchangers.

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**BUNTING**—Bunting Brass & Bronze Co., Toledo. A line of some 160 bearing bronzes available as fully-machined bar stock and ready-cut bushings, including the following:

Alloy No. 27; phosphor bronze (leaded) for bearings.

Alloy No. 51; for low speeds, heavy loads, gears; free-machining.

Alloy No. 72; general purpose bearing bronze; used in standard stock items.

Alloy No. 96; high strength, excellent machinability, low speeds, heavy loads.

Alloy No. 124; camshaft bearings, piston pin bearings, etc.

Alloy No. 125; high lead, low friction, scanty lubrication applications.

Alloy No. 135; for average bushing applications.

Alloy No. 156; hard gear bronze.

Alloy No. 164; nickel gear bronze, synchronizer cones.

Alloy No. 178; copper-lead precision type main and connecting rod bearings.

Babbitt; genuine babbitt, lead base babbitt.

Precision; cored and solid fully-machined bar stock from dense grained bearing bronze.

***See advertisement, Page 6-D***

## C

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**CMP STRIP**—The Cold Metal Process Co., Youngstown, O. Precision cold rolled strip steel, of carbon and alloy steels. Has regular finish, bright mirror finish (one or two sides), blued finish (both sides) and sand-blasted finish (one or two sides).

1 2 - 4 - - - - - - -

**CANNON 3½ PER CENT NICKEL STEEL**—Cannon-Stein Steel Corp., Syracuse, N. Y.

S.A.E. 2315; carbon .15, manganese .45, phosphorus .04, sulphur .05, silicon .30, nickel .35; brinell hardness untreated 174; recommended heat treatment carburized at 1650 degrees Fahr., heat treated at 1450-1500 degrees Fahr. oil quenched. Resists corrosion due to nickel content; resists heat to 800-1000 degrees Fahr.; tensile strength 85,000 lbs. per sq. in. as rolled; for king pins, rock drill parts, air hammer parts, universal joints, bolts, shafts, studs, etc.

S.A.E. 2320; carbon .20, manganese .50, phosphorus .04, sulphur .05, silicon .03 max., nickel 3.50; brinell hardness untreated 174; recommended heat treatment carburized at 1650 degrees Fahr., heat treated at 1450-1500 degrees Fahr.; resists corrosion due to nickel content; resists heat to 800-1000 degrees Fahr.; tensile strength 90,000 lbs. per sq. in. as rolled; for uses same as S.A.E. 2315.

1 2 3 - - - - - - - -

**CARBOLOY**—Carboloy Co. Inc., Detroit. A series of cemented carbides basically made from tungsten carbide and a softer cementing element such as cobalt. In certain grades, supplementary ingredients are the carbides of tantalum, titanium or other metals. Has high resistance to abrasive and corrosive wear; outstanding on account of its extreme hardness, compressive strength being as high as 800,000 lbs. per sq. in.; Rockwell hardness on "A" scale 86-93; does not rust or corrode under normal conditions. Recommended as wear resistant inserts for machine parts subject to extreme wear such as cams, cam followers, hydraulic valve stems and seats, machine tool rests, etc.

- - 3 - - - - - - - -

**CARBOMANG**—Detroit Alloy Steel Co., Detroit. Furnished as castings. Carbon .90-1.00, manganese 1.00-1.10, chromium .40-.60; medium abrasion; tensile strength, ult., 125,000 lbs. per sq. in.; compressive strength, ult., 200,000 lbs. per sq. in.; medium ductility; brinell hardness, untreated 200, heat treated 600; for air-hardening tool steel castings.

1 2 3 4 5 6 7 - - -

**CARPENTER**—The Carpenter Steel Co., Reading, Pa.

1 2 - 4 - - - - - - -

Stainless No. 3; chromium 20, copper 1; for special chemical apparatus and scale resisting parts.

1 - 3 4 - - - - - - -

Stainless No. 2; carbon .3; chromium 13; used in fully hardened condition for ball bearings, ball check valves, cutlery, instruments, etc.

Stainless No. 2B; carbon 1, chromium 17; uses same as No. 2.

1 2 - - - - - - - - -

Stainless No. 3; chromium 20, copper 1; for special chemical apparatus and scale resisting parts.

1 2 - 4 - - - - - - -

Stainless No. 4; carbon .1, chromium 18, nickel 8; for rolled moldings, stampings, etc.; also has high ductility.

Stainless No. 5; carbon .1, chromium 14, sulphur .30; a free machining grade for automatic screw machine parts, valve trim, pump shafts, etc. Is heat resistant.

1 - - - 5 - - - - - -

Stainless No. 6; carbon .1, chromium 16 to 18; uses same as No. 1 and No. 4.

1 - 3 - - 6 - - - - -

Stainless No. 8; carbon .1, chromium 18, nickel 8, selenium .25; a free machining grade; heat resistant.

- - - - - - - 7 - - -

Chrome magnet steel; carbon .95, chromium 3.5; for magnets in meters and other electrical apparatus.

- - 3 - - 6 - - - -

Presto; carbon 1.05, chromium 1.4; for ball and roller bearings.

- - - 4 - - - - - - -

Silico-manganese steel; carbon .6, manganese .75, silicon 2; for heavy duty springs.

- - 3 4 - - - - - - -

No. 5-317; chrome nickel steel; carbon .5, nickel 1.75, chromium 1; for gears, clutches and shafts.

No. 5 Samson; carbon .5, nickel 1.25, chromium .6; for gears and clutches.

No. 4-408; carbon .4, nickel 3, chromium .75; for clutches and shafts.

- - 3 4 5 - - - - - -

No. 158; carbon .1, nickel 3.5, chromium 1.5; for case hardened high duty clash gears, shafts, clutch parts.

- - 3 4 - - - - - - -

No. 4 Samson steel; carbon .4, nickel 1.25, chromium .6; for side links of silent chains, shafts, axles, etc.

- - 3 - 5 - - - - - -

No. 2 Samson; carbon .2, nickel 1.25, chromium .6; for case-hardened gears, roller bearings, pneumatic tool parts, etc.

- - 3 4 - - - - - - -

No. 3-547; nickel steel; carbon .3, nickel 3.5; for heat treated shafts, etc.

- - 3 - 5 - - - - - -

No. 2-547; case hardening nickel steel; carbon .2, nickel 3.5; for small parts requiring hard surface and tough core.

No. 500; carbon .1, nickel 5; for turbine blades, case-hardened gears, etc.

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Chrome vanadium 5-720; carbon 5, chromium .9, vanadium .2; for leaf and coil springs, gears, shafts, etc.

No. 3-427 chrome molybdenum steel; carbon .3, chromium 1, molybdenum .2; for aircraft and automotive parts.

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No. 436; carbon .15, nickel 1.75, molybdenum .25; for case-hardened parts.

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Temperature compensator alloy; iron-nickel alloy; furnished in rough bars or billets, finished rods or bars, wire and strips for hot forging, stamping, turning, boring, etc.; permeability varies inversely as temperature; for magnetic shunts for meters, speedometers, tachometers, voltage regulators, etc.

***See advertisement, Page 91-D***

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**CAST ALLOY STEEL**—The Alloy Cast Steel Co., Marion, O.

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Nickel steel castings; carbon .30-.40, manganese .60-.80, sulphur .05 max., phosphorus .045 max., silicon .35-.45, nickel 3.25-3.75; has high strength and resistance to shock and fatigue; used largely in annealed condition, although responds to heat treatment.

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Nickel chrome steel castings; carbon .35-.45, manganese .60-.80, phosphorus .045 max., sulphur .05 max., silicon .35-.45, nickel 1.50-2.00, chromium .60-.75; has high strength and wear resistance.

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Nickel, chrome, molybdenum steel castings; carbon .35-.45, manganese .60-.80, phosphorus .045 max., sulphur .050 max., silicon .35-.45, nickel 1.50-2.00, chrome .60-.75, molybdenum .25-.45; used in parts which must be strong and hard and where size or shape prevent liquid quenching.

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Manganese molybdenum steel castings; carbon .30-.40, manganese 1.25-1.60, phosphorus .045 max., sulphur .050 max., silicon .35-.45, molybdenum .25-.45; used for gears, sprockets, levers, etc.

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Medium manganese steel castings; carbon .30-.40, manganese 1.25-1.50, phosphorus .045 max., sulphur .050 max., silicon .35-.45; used in power shovels, tractors, road machinery, etc.

High manganese steel castings; carbon 1.10-1.30, manganese 10.50-13.50, phosphorus .10

and under; tensile strength, 80,000-90,000; yield, 40,000-50,000; cannot be machined readily and is usually finished by grinding.

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**CASTOLOY**—Detroit Alloy Steel Co., Detroit. Furnished as castings. Chromium 12-14, carbon 1.5-1.6, cobalt .70, molybdenum .85; semiresistant; heat resistant to 1000 degrees Fahr.; medium abrasion resistance; tensile strength, ult., 100,000 lbs. per sq. in.; compressive strength, ult., 350,000 lbs. per sq. in.; medium ductility; good bearing and magnetic properties; used for bearings, cams, valve seats and spindles.

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**CECOLLOY** — Chambersburg Engineering Co., Chambersburg, Pa.

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A; carbon 3.00; molybdenum .50, nickel .60; shock resistance, vibration damping, and close grain.

B; carbon 2.80, molybdenum .50, chromium .25; also has shock resistance, is vibration damping and has close grain in heavy sections.

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C; carbon 3.00, molybdenum .50; nickel 1.50; properties similar to type A.

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**CECOLLOY IRON**—Chambersburg Engineering Co., Chambersburg, Pa.; carbon 3, manganese .90, silicon 1.30, nickel 60, molybdenum .50; suitable for casting in cement-bonded sand molds; resists corrosion to atmospheric conditions and acids; has tensile strength 56,000 lbs. per sq. in.; brinell hardness of 255; for steam cylinder liners, cylinders, rings and valves; also beds for heavy duty machine tools.

**CERROBASE**—Cerro de Pasco Copper Corp., New York. Bismuth-lead casting alloy which expands on cooling; melts at 255 degrees Fahr.; tensile strength 6100 lbs. per sq. in.; recommended for master patterns, electroforming, engraving machine models, etc.

**CERROBEND**—Cerro de Pasco Copper Corp., New York. Bismuth-lead-tin-cadmium casting alloy which expands on cooling and has the extremely low melting temperature of 160 degrees Fahr.; tensile strength of 6000 lbs. per sq. in.; useful as a fusible alloy and as a filler for tube bending.

**CERROMATRIX**—Cerro de Pasco Copper Corp., New York. Bismuth-lead-tin-antimony casting alloy which melts at 248 degrees Fahr. and expands on cooling; tensile strength 13,000 lbs. per sq. in.; used for locating and anchoring machine parts in cored holes.

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**CHACE THERMOSTATIC BIMETAL**—W. M. Chace Co., Detroit. Thermostatic bimetals; a number of combinations including alloys of nickel-iron, nickel-iron-chromium, nickel-iron-manganese, pure nickel, brass, bronze, etc.; responsive to various temperature ranges and provide a wide range of deflection rates and electrical resistivities; for temperature control elements in controllers, recorders, indicators, circuit breakers, etc.

*See advertisement, Page 83-D*

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**CHAMET BRONZE**—Chase Brass & Copper Co., Waterbury, Conn. Copper 62, tin .65, zinc 37.35; for general use where relatively corrosion resistant brass is required.

Leaded; Copper 62, tin .65, lead 1.5, zinc 35.85; for forming of parts on automatic screw machines where a free-cutting relatively high-strength corrosion resistant brass is required.

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**CHASE**—Chase Brass & Copper Co., Waterbury, Conn.

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Cupro-Nickel; copper 70, nickel 30; largely used for condenser tubes particularly for extreme service in very corrosive waters.

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Free-cutting commercial bronze; copper 89, lead 2, zinc 9; for screw machine parts requiring good physical properties and high corrosion resistance.

Also various high and low brasses and bronzes in various forms to meet specific requirements for a variety of mechanical parts.

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**CHASE 444 BRONZE**—Chase Brass & Copper Co., Waterbury, Conn. Copper 88, tin 4, lead 4, zinc 4; a high-strength, free-machining, general purpose alloy particularly recommended for bushings and bearing applications. For bushings it shows excellent resistance to wear and deformation. This material is available in strip only.

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**CHASE TELLURIUM COPPER**—Chase Brass & Copper Co., Waterbury, Conn.

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Type A; copper 99.5, tellurium .5; furnished in finished rods or bars and tubing for hot forging, extruding, turning, boring, etc.; corrosion resistant; resists heat up to 450 degrees Fahr.; medium abrasion resistance; tensile strength 32,000-55,000 lbs. per sq. in.; medium ductility; brinell hardness, untreated 90; for electrical connections, parts for electric motors, switches, etc.

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Type B; copper 98.3, nickel 1, tellurium .5 and phosphorus .2; resists heat up to 450 degrees Fahr., medium abrasion resistance; tensile strength 40,000-70,000 lbs. per sq. in.; specific gravity, .323 lbs. per cu. in.; brinell hardness, untreated 50, heat treated 125; for marine hardware, locks and bolts, etc.

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**CHROMALOID**—American Nickeloid Co., Peru, Ill. Chromium bonded to nickel-bonded zinc, latter serving as rustproof, flexible and inexpensive white metal base. Available in variety of brilliant finishes and patterns, as sheets, flat strips and coiled strip for continuous feed automatic presses. Can be supplied with quick removable, gum adhered paper covering permitting drawing and forming without marring pre-finish. For reflectors, automotive details, washing machine parts, and for other stamped and formed parts requiring brilliant, permanent finish.

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**CHROMAX**—Driver-Harris Co., Harrison, N. J. A heat resisting alloy used for carburizing containers or furnace parts; nickel 35, chromium 19, and balance iron.

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**CHROMEL**—Hoskins Mfg. Co., Detroit.

Alloy 502; nickel 35, chromium 18½, balance mainly iron; supplied as castings, or as rod, bars and strips. For general heat resistant applications and for mechanical and load-carrying members which are heated to 2000 degrees Fahr.

Alloy 670; chromium 25, nickel 12, balance mainly iron; supplied as castings or as rod, bars and strips; for high temperature applications where sulphur corrosion must be withstood.

Grade A; nickel 80, chromium 20, supplied as castings or as rod, bars, wire and strip; used for electric heating elements up to 2100 degrees Fahr.

Grade C; nickel 60, chromium 16, balance mainly iron; used for electric heating elements to 1700 degrees Fahr.; also used for rheostatic purposes; supplied as castings, or as rods, bars and strip.

Grade D; nickel 35, chromium 18½, balance mainly iron; used for heating elements to 1400 degrees Fahr.; available cast, or as wire, rod and strip.

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**CHROMEWELD 4-6**—Lincoln Electric Co., Cleveland. For the welding of steels commonly known as 5 per cent chromium steels. Annealed at 1550-1600 degrees Fahr.; cooled slowly and stress relieved at 1400 degrees Fahr. will have tensile strength of 80,000-90,000 lbs. per sq. in.; yield point 55,000-65,000 lbs. per sq. in.; elong. in 2 in., 24-30 per cent; reduction in area 60-70 per cent; brinell hardness, 155-175.

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**CIMET** — Driver-Harris Co., Harrison, N. J. Nickel 10-12, chromium 26-28, and balance iron; castings for furnace parts in high sulphur atmospheres, and for acid resisting castings in the form of pump impellers, piping, etc.

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**CIRCLE L**—Lebanon Steel Foundry, Lebanon, Pa. This tradename covers castings in forty-three different types of alloys including the following:

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No. 1; manganese 1.40, carbon .35, with vanadium or molybdenum.

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No. 2; carbon .32, chromium .75, molybdenum .30, manganese 1.40; for crankshafts, airplane parts, valves and other castings.

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No. 3; carbon .40, chromium 1.25, vanadium .12, molybdenum .40, manganese .75; for gears and cams, and nitrided parts.

No. 5; carbon .30, chromium .75, nickel 1.75, molybdenum .30; for highly stressed parts.

No. 6; carbon .15, nickel 1.75, molybdenum .25 for cams, gears and other case hardened parts (carburizing).

No. 9; carbon .25, molybdenum .45; for parts subject to temperature.

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No. 10; carbon .20, chromium 5.50, molybdenum .55; for high pressure and high temperature applications in the oil industry.

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No. 11; carbon .25, chromium 18; stainless steel; for parts subject to nitric acid corrosion.

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No. 12; carbon .10, chromium 13; stainless steel; for chemical apparatus, etc.

No. 13; carbon .25, chromium 13; for stainless steel parts where high hardness is essential.

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No. 15; carbon .30, chromium 27; heat and corrosion service.

No. 22; carbon .07 max., chromium 19.0, nickel 9; for miscellaneous stainless parts and castings to be polished. Also made with molybdenum and/or columbium as required.

No. 23; carbon .15, chromium 19.0, nickel 9; miscellaneous stainless alloy castings.

No. 30; carbon .15, chromium 24, nickel 10; for valves, pumps and miscellaneous parts for the paper industry.

No. 31; carbon .22, chromium 28, nickel 11; resistant to temperatures up to 2000 degrees Fahr.

No. 32; carbon .50, chromium 15, nickel 35; heat resisting castings requiring strength at elevated temperatures.

No. 34; carbon .06, chromium 20, nickel 30, molybdenum 3, plus copper.

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**CLOVERLEAF BABBITT**—E. A. Williams & Son Inc., Jersey City, N. J. Babbitt metal in grades A, B and 0 and 1, 2, 3 and 4 for bushings, bearings, etc.

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**COLALLOY**—Colonial Alloys Co., Philadelphia. Furnished in sheets, plates, circles, strip, tubes, coils, pipes, rods, angles, shapes and other forms; can be easily formed, bent, machined, fabricated, welded, etc.; has wide range of tensile strengths, brinell hardness; medium and high ductility; good bearing properties; nonmagnetic; for use as disks, chucks, pulleys, guards, mountings, feed brackets, lever knobs, covers, spindles, rings, collars, bushings, housings, tubes, fastenings, etc.

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**COLMONOY** — Wall-Colmonoy Corp., Detroit. Welding rods available in the following grades:

No. 1; chromium, boron, iron welding rod; Rockwell hardness, untreated, 58-60 C.; abrasion resistant.

No. 4; nickel-chromium-boron cast welding rods; for hard-facing parts requiring easy machinability on the overlay metal; corrosion, heat and abrasion resistant; Rockwell hardness, untreated, 40 C.

No. 5; nickel-chromium-boron cast welding rod; for hard-facing parts subject to considerable abrasion and corrosion, and where machined finish is required; Rockwell hardness, untreated 50 C.

No. 6; cast welding rods; for hard facing parts subject to maximum abrasion and corrosion, and which require a machined finish; heat resistant.

No. 20; nickel-chromium-boron welding rods; for patching or overlaying cast iron and Meehanite dies and parts; corrosion resistant; resists heat up to 1800 degrees Fahr.; medium abrasion resistance and ductility; Rockwell hardness, untreated, 20 C.

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**COLUMBIA**—Columbia Steel & Shafting Co., Pittsburgh; furnished in rods and bars, tensile strength is high; bearing properties good; material machines freely.

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**CONTINENTAL SUPER STEEL**—Continental Roll & Steel Foundry Co., East Chicago, Ind. Chrome-nickel-molybdenum rolling mill rolls for billet, blooming, merchant and bar mills.

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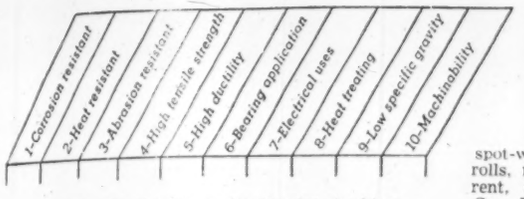
**COMMERCIAL**—Buckeye Brass & Mfg. Co., Cleveland. Cored and solid bronze bars;




copper 80, tin 10, lead 10; for bushings, bearings and bars.

*See advertisement, Page 25-D*

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**COMPO**—Bourd Brook Oil-less Bearing Co., Bound Brook, N. J. Oil-retaining porous bronze bearings and washers; copper 88.75, tin 9.75, graphite 1.5; porous structure containing as high as 35 per cent of oil or other lubricant by volume. Used in automobiles, airplanes, household appliances, machine tools, electric motors, etc.

*See advertisement, Page 81-D*

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**COOPER ALLOY**—(Formerly Sweetaloy)—Cooper Alloy Foundry Co., Elizabeth, N. J.

No. 16; 18 per cent chromium iron.
No. 17; 18 chromium and 8 nickel.
No. 18; 22 nickel and 10 chromium.
No. 19; 28 per cent chromium.
No. 20; 36 nickel and 18 chromium.
No. 21; 65 nickel and 15 chromium.
No. 22; 28 chromium and 10 nickel; this and above alloys furnished in castings for chemical plant, paper mill, textile and food processing machinery.

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**COPEL**—Hoskins Mfg. Co., Detroit. Copper 55, nickel 45; used mostly for thermostatic purposes, also for heating elements to 800 degrees Fahr. Temperature coefficient of resistance is practically nil.

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**COPPEROID**—American Nickeloid Co., Peru, Ill. Copper bonded to zinc, latter serving as rust-proof, flexible and inexpensive white metal base. Available in variety of brilliant finishes and patterns, as sheets, flat strips and coiled strip for use in continuous feed automatic presses. Can be supplied with quick removable gum adhered paper covering permitting drawing and forming operations without marring pre-finish. For machinery trim, nameplates, change gear index plates, etc.

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**CRAMP ALLOYS**—Cramp Brass & Iron Foundries Division Baldwin Locomotive Works, Philadelphia.

No. 49; furnished in rough bars or billets, rods or bars, and sand castings; resists heat to 400 degrees Fahr.; high abrasion resistance; tensile strength 120,000 lbs. per sq. in.; compressive strength 55,000; medium ductility; specific gravity, 6.8; good bearing properties; used for heavy duty, slow moving loads.

No. 99; furnished in rough bars or billets and rods or bars; resists corrosion by sulphuric, sulphurous, acetic acids; heat resistant to 450 degrees Fahr.; high abrasion resistance; tensile strength 55,000 lbs. per sq. in.; compressive strength 22,000; good bearing properties; brinell hardness, untreated 100; used for high speed bearings and acid resisting parts.

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**CRASFLOY**—Continental Roll & Steel Foundry Co., East Chicago, Ind. Hard alloy gray iron rolling mill rolls made in four grades: mild, medium, hard and super hard.

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**CROMIN D**—Wilbur B. Driver Co., Newark, N. J. Nickel-chromium-iron; high resistivity, for use in low temperature work.

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**CROMONITE**—Continental Roll & Steel Foundry Co., East Chicago, Ind. Hard alloy chill roll made in four grades, mild, medium, hard and super-hard

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**CUFERCO**—Westinghouse Electric & Mfg. Co., East Pittsburgh. Copper-iron-cobalt alloy resembling Cupaloy, but has greater strength, higher heat resistivity, more mechanical endurance, and somewhat lower electrical conductivity.

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**CUMLOY**—West Steel Casting Co., Cleveland. A molybdenum-vanadium-nickel alloy for steel castings such as cams, gears, levers, and indexing mechanism parts.

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**CUPALOY**—Westinghouse Electric & Mfg Co., East Pittsburgh, Pa. Copper base alloy containing chromium and silver; thermal and electrical conductivity 80-90 per cent pure copper; tensile properties of steel; brinell hardness of 140-160; applications include spot-welding tips, seam-welding wheels and rolls, mechanical parts carrying heavy current, etc. Licensees: A. W. Cadman Mfg. Co., Pittsburgh.

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**D-H-S BRONZE**—Koppers Co., Bartlett-Hayward Div., Baltimore. Furnished in rough bars or billets, rods or bars, also as sand castings; zinc 21-25, copper 61-65, hardener (aluminum, manganese and iron) 13-15; resists corrosion, heat resistant to 400 degrees Fahr.; high abrasion resistance; tensile strength, 100,000-130,000 lbs. per sq. in.; compressive strength 90,000; specific gravity .278 lbs. per cu. in.; nonmagnetic; brinell hardness, untreated 200-260; used for heavy-duty bearings, gears, guides, screws, stems, nuts, etc.

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**DM-45**—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O. Carbon .40-.50; manganese .40-.70, silicon .50-.80, chromium 1-1.5, molybdenum .45-.65; furnished in rough bars or billets, and finished rods or bars, for hot forging, turning, boring, etc., into parts. Material resists heat to 1100 degrees Fahr.; tensile strength, 150,000 lbs. per sq. in., min., heat treated; medium ductility; and brinell hardness, untreated 185, heat treated 411 max. For bolts, studs and other highly-stressed parts used at elevated temperatures.

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**DM STEEL**—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O. Carbon .15 max., manganese .30-.60, silicon .50-1, chrome 1-1.5, molybdenum .45-.65, phosphorus .03 max., sulphur .03 max.; furnished in rough bars or billets, finished rods or bars, and tubing, for hot forging, welding, turning, boring, etc. into parts. Material resists heat to 1100 degrees Fahr.; tensile strength, ult., 60,000 lbs. per sq. in., min.; medium ductility; fair weldability; and brinell hardness, annealed 163 max. Used for oil refinery field.

Type 2; similar to above with slightly varied analysis; resists heat to 1050 degrees Fahr.; tensile strength, ult., 60,000 lbs. per sq. in. min.; medium abrasion resistance; fair weldability; brinell hardness, annealed 163 max. For oil refinery field, also.

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**DEFIHEAT**—Rustless Iron & Steel Corp., Baltimore. No. 446 stainless type carbon .35 max., chromium 23 to 30; resists nitric and sulphuric acids, also heat to 2000 degrees Fahr.; for furnace parts and other applications involving high heat.

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**DEFIRUST**—Rustless Iron & Steel Corp., Baltimore.

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No. 410 stainless type; carbon .15 max., chromium 10-14; hardening type of stainless steel for turbine blades.

No. 416 machining type; carbon .15 max., sulphur .15 and chromium 12-14; hardening type of stainless steel possessing free-cutting properties.

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**DEFISTAIN**—Rustless Iron & Steel Corp., Baltimore.

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Types 302, 304 and 308; carbon .08-.12 max. or .08 max., manganese 2 max., chromium 18-22, nickel 8-12; retains high tensile strength and resistance to creep to 1300 degrees Fahr.; nonmagnetic; resists nitric acid, salt air, and food; resists heat to 1600 degrees Fahr.; recommended for machinery parts which come in contact with food.

Type 303, machining; carbon .20 max., sulphur .15 min., chromium 18-20 and nickel 8-10; has high ductility and free-cutting properties; resists heat to 1550 degrees Fahr., and has tensile strength to 200,000 lbs. per sq. in.; recommended for same purposes as above where free cutting is desirable.

Rustless 18-12 Mo., types 316-317; carbon .09 max., chromium 16-20, nickel 14 max., molybdenum 2-4; corrosion resistant; used for parts in paper and pulp, and chemical industries.

Columbium type 347; carbon .10 max., chromium 17-20, nickel 8-12; columbium ten times carbon; same properties as Defistain except welded equipment does not require annealing after welding; material is stabilized.

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**DELLOY**—Delloy Metals, Philadelphia.

Type No. 9; chromium 30.7, cobalt 48.2, tungsten 17.5, carbon 2.2; corrosion resistant; resists heat to 2700 degrees Fahr.; high abrasion resistance; tensile strength 60,000 lbs. per sq. in.; good weldability; for parts where wear resistance is required.

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**DEWARD**—Allegheny-Ludlum Steel Corp., Pittsburgh. Carbon .9, manganese 1.50, molybdenum .30; for holders for thread chasers and gang punches. Oil hardening.

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**DIAMOND G BRONZE**—E. A. Williams & Son Inc., Jersey City, N. J. For bearings, bushings and mill brasses, either finished or in the rough.

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**DIXOILBRONZ**—Thos. F. Seitzinger's Sons, Atlanta, Ga. Bearing bronze, copper base, balance tin and lead with no agents or hardener; resists corrosion due to high lead content; heat resistant to 700 degrees Fahr.; tensile strength, ult., 18,000-30,000 lbs. per sq. in.; compressive strength, ult., 7800-14,000; bearing properties, good; recommended for bearings, bushings, gears, pump runners, pump liners, and for oil field equipment.

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**DOLE THERMOSTATIC BIMETAL**—The Dole Valve Co., Chicago. Furnished in strips and fabricated elements; for stamping and coiling; good magnetic properties; good weldability; recommended heat treatments are 600-700 degrees Fahr.; free end of thermal element deflects proportionately with changes in temperature; used to provide protection against excessive temperature and temperature control at predetermined temperatures.

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**DOLER-ALUMIN**—Doehler Die Casting Co., New York. Aluminum base die castings. Composition suited to meet stringent requirements, as high tensile strength, impact strength, hardness, corrosion resistance, thermal conductivity and electrical conductivity.

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**DOLER-BRASS**—Doehler Die Casting Co., New York. Brass die castingss. Composition suited to meet varying conditions. Tensile strength to 100,000 lbs. per sq. in., and hardness to 180 brinell; excellent corrosion resisting properties.

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**DOLER-MAG**—Doehler Die Casting Co., New York. Magnesium base die castings made from the lightest of the commercial metals; one-third lighter than aluminum.

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**DOLER-ZINK**—Doehler Die Casting Co., New York. Zinc base die castings of maximum tensile and impact strength.

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**DOWMETAL**—The Dow Chemical Co., Midland, Mich. Magnesium alloy ingots, castings, wrought forms, rods, bars, sheet, shapes, extrusions, sand and die castings; also forgings, magnesium metal ingots and magnesium metal sticks.

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**DRAGON**—Allegheny Ludlum Steel Corp., Pittsburgh. Carbon .33, manganese .55, chrome .65, molybdenum .35; high degree of toughness with moderate hardness; water hardening; for use as bucket teeth, keys, pins, bolts, studs, etc.

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**DRIVER-HARRIS 42 ALLOY**—Driver-Harris Co., Harrison, N. J. Notable for its coefficient of linear expansion—approximately that of different grades of glass.

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**DRIVER-HARRIS 52 ALLOY**—Driver-Harris Co., Harrison, N. J. Alloy of nickel and iron which has been successfully used for sealing in glass and in which process no coating is required prior to the operation.

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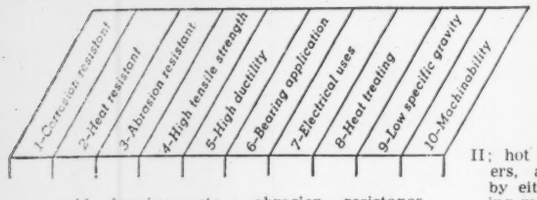
**DUCTILOY**—Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Detroit. Carbon 15, manganese .70, chrome .55, silicon .85, nickel .15, copper .20, zirconium .15, phosphorus .025, sulphur .025; furnished in rough bars or billets, finished rods or bars, sheets, strips, plates, for hot forging, stamping, extruding, turning, boring, welding,




cold forming, etc.; abrasion resistance, medium; tensile strength, ult., 75,000-80,000 lbs. per sq. in.; ductility, high; specific gravity, 7.85; weldability, good; brinell hardness, untreated 160; fatigue and impact resistant; for frames, bases, small axles and power transmission shafting.

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**DUPLEX**—Crucible Steel Co. of America, New York.

No. 1; nickel 3.50, chromium 1.50; forging steel, for shafts and machine parts requiring high strength and toughness; also made in case carburizing type.

No. 2; nickel 1.75, chromium 1; also a forging steel for applications similar to those of No. 1, and made in case carburizing type.

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**DUQUESNE SPECIAL**—Continental Roll & Steel Foundry Co., East Chicago, Ind. Chrome nickel molybdenum steel for rolls subject to severe service; also for abrasive castings.

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**DURACAST**—West Steel Casting Co., Cleveland. For steel castings of 90,000 lbs. per sq. in. tensile strength and brinell hardness of 180; cams, gears, etc.

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**DURCO**—Duriron Co. Inc., Dayton, O. Alloy steels (KA2S, KA2SMo., etc.); 18 chrome, 8 nickel, carbon max. .07, and other standard as well as special analyses preferred by users; for pumps, valves, fittings, castings for corrosive service, etc.

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**DUREX**—Moraine Products Div., General Motors Corp., Dayton, O. Product of powder metallurgy in iron, bronze and other metals; self-oiling bearings and various small parts for electric motors, automobiles, domestic and other machinery.

***See advertisement, Page 26-D***

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**DURICHLOR**—Duriron Co. Inc., Dayton, O. Silicon 14.5, molybdenum 4, carbon .80, traces of phosphorus and sulphur, balance iron; for pumps, valves, pipe, castings for corrosive service, especially for hydrochloric acid and chloride solutions.

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**DURIMET**—Duriron Co. Inc., Dayton, O. Nickel 22, chromium 19, silicon, molybdenum and copper 5 approx., carbon .07 max., balance iron; for pumps, valves, bolts, nuts and castings for corrosive service, especially weak sulphuric acid.

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**DURIRON**—Duriron Co. Inc., Dayton, O., and licensees. Silicon 14.50, carbon .80, manganese .60, sulphur and phosphorus traces, balance iron; for pumps, valves, exhaust fans, mixing nozzles, and castings for handling acids and other corrosive liquids and gases.

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**DURO-GLOSS**—Jessop Steel Co., Washington, Pa. Stainless steels in following grades:

C-1, type 410; ult. strength, 70,000 lbs. per sq. in.; yield point, 40,000 lbs. per sq. in.; elongation in 2 inches, 35 per cent; used for automotive, chemical and electrical appliance equipment, gates and valves, etc.

C-2, type 430; ult. strength 80,000 lbs. per sq. in., yield point 50,000 lbs. per sq. in.; elongation in 2 inches 35 per cent; brinell hardness, 163; used for chemical plant equipment, condensers, steam engine parts, pump shafts, fans, blowers, restaurant equipment, etc.

C-3, type 442; ult. strength 80,000 lbs. per sq. in.; yield point 55,000 lbs. per sq. in., elongation in 2 inches, 35 per cent; brinell hardness, 171; used for same type of applications as C-4, but intended for use at slightly lower temperatures.

C-4, type 446; ult. strength 90,000 lbs. per sq. in.; yield point, 55,000 lbs. per sq. in.; elongation in 2 inches, 25 per cent; brinell hardness, 171; used for tubes, manifolds, linings, etc.

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**DURONZE ALLOYS** — Bridgeport Brass Co., Bridgeport, Conn. High copper silicon bronzes alloyed with elements such as tin, iron, aluminum, etc.; possess high strength combined with corrosion resistance.

I; possesses excellent cold working properties; for making cold headed bolts and screws, average 100,000 lbs. per sq. in. tensile strength; available in rod, wire and sheet form.

II; hot rolled sheet for making range boilers, automatic heaters and storage tanks by either electric arc or oxyacetylene welding methods; cold rolled strip used as a substitute for phosphor bronze spring metal; rod and wire used for making hot headed bolts and screw products; supplied in sheet, rod, wire, and ingot forms.

III; supplied in rod form only; tensile strength from 85,000-100,000 lbs. per sq. in.; hot forgings 90,000 lbs. per sq. in.; free machining for making screw machine parts, also for sucker rods for corrosive oil wells; ten per cent lighter than brass; excellent corrosion resistance; in ingot form may be used for making sand castings with tensile strength about 70,000 lbs. per sq. in.

IV; made into condenser tubes only; for resisting corrosion from aerated sea water.

V; wire for making difficult cold headed parts, screws, bolts, rod, sheet and tubing for outdoor service; malleable; good corrosion resistance; tensile strength, about 100,000 lbs. per sq. in.; for outdoor use.

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**DUTCH BOY BABBITT**—National Lead Co., New York. Analysis varies for different bearing applications.

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**DYNAMIC STEEL**—Continental Roll & Steel Foundry Co., East Chicago, Ind.

C-2; carbon-manganese-nickel cast steel for parts requiring high physical properties; for tractor frames, locomotive castings, etc.

C-3; carbon-manganese-nickel cast steel for resisting wear after a preferential heat treatment; for sprockets, spindles, wheel centers, cross heads, etc.

C-3-A; carbon-manganese-molybdenum cast steel for parts requiring high physical properties, with machinability; for gears, racks, sprockets and miscellaneous castings.

C-4; nickel-vanadium alloy; heat treated, having high physical properties especially suitable for rolling mill pinions.

C-5; carbon-manganese-nickel-moly steel for rams and saw blocks; high physical properties and high impact value.

C-6; chromium cast steel for special abrasive and crushing work; for sand mills, rock crushers, etc.

C-7; carbon-chromium-nickel-molybdenum cast steel for castings requiring high physical and severe service qualities.

C-8; carbon-manganese-vanadium steel for air hardening.

C-10; carbon - chrome - molybdenum - vanadium steel for die blocks and crane wheels; superior wear resistance and high physical properties.

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**DYN-EL**—Alan Wood Steel Co., Conshohocken, Pa. Furnished in sheets, strips, and plates, for stamping, welding, cold and hot forming, etc.; abrasion resistance medium; tensile strength 70,000-80,000 lbs. per sq. in.; ductility high; weldability good; fatigue and impact values high; for structures requiring high strength.

## E

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**EASY-FLO**—Handy & Harman, New York. Brazing alloy; silver 50, copper 15.5, zinc 16.5, cadmium 18; resists corrosion due to silver content; specific gravity 9.49; for brazing ferrous and nonferrous metals, particularly dissimilar metals and monel metal, stainless steel and other copper-nickel and chrome-nickel alloys. Has many electrical uses.

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**ECONOMET**—General Alloys Co., Boston. Nickel 30, chromium 10; resists heat to 1800 degrees Fahr.; tensile strength, 70,000 lbs. per sq. in.; castings subject to high temperatures.

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**ECONOMO**—Wheelock Lovejoy & Co. Inc., Cambridge, Mass. Carbon .20 and .50 with alloy of molybdenum; free machining; for machine tool parts.

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**EIS 45**—Heppenstall Co., Pittsburgh. Carbon .85 chrome .12. Furnished for hot forging into parts. Used for shear blades for shearing medium heavy material.

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**EIS 57**—Heppenstall Co., Pittsburgh. Nickel chrome-molybdenum-steel, .6 carbon; for insert and hot die steel service.

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**ELASTUF**—Horace T. Potts Co., Philadelphia. (Note: "Elastuf", together with each of the following types, is a copyrighted term which should be used in specifying these materials. Thus, "Elastuf Type A Heat Treated," etc.)

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Type A steel, heat treated; special analysis chrome vanadium steel; carbon .25-.35 up to 2 in. round, and carbon .45-.55 over 2 in. round; furnished in rough bars or billets and forgings, for turning, boring, etc. Has excellent tensile strength at elevated temperatures. Used where maximum strength, resistance to impact, fatigue, wear, shear or compression is required.

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Type A alloy steel, annealed; special analysis chrome vanadium steel; carbon .45-.55; furnished in rough bars or billets and forgings. Brinell hardness, untreated 200, heat treated 600. For parts which must be hardened and where maximum toughness is required such as cams, plastic molds, mandrels, clutch parts, etc.

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Type C. H. free machining case hardening steel, hot rolled; furnished in rough bars or billets, and finished rods or bars, for turning, boring, etc.; tensile strength 70,000 lbs. per sq. in.; high ductility; used for mass production parts needing machinability and excellent case hardening properties.

Licensees are: Brown-Wales, Boston; Beals, McCarthy & Rogers Inc., Buffalo; Equitable Equipment Co., New Orleans.

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**ELASTUF CHRO-MOLY**—Horace T. Potts Co., Philadelphia. Chrome - molybdenum alloy steel, hot rolled, heat treated; carbon .35-.45 up to 4 in. round, and .45-.55 carbon over 4 in. round; furnished in rough bars or billets and forgings, for turning, boring, etc. Used for heavy-duty parts requiring high tensile properties with exceptional impact strength.

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**ELASTUFF "44"**—Horace T. Potts Co., Philadelphia. Chrome-nickel-molybdenum alloy steel furnished in rough bars or billets. Has high abrasion resistance; tensile strength, ult., 220,000 lbs. per sq. in.; medium ductility; and brinell hardness, heat treated, approximately 420. Used for gears, pinion shafts, and for parts requiring high strength and high hardness.

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**ELASTUF PENN**—Horace T. Potts Co., Philadelphia. Hot rolled steel furnished in rough bars or billets, and finished rods or bars for hot forging, turning, boring, etc.; tensile strength 125,000 lbs. per sq. in.; medium ductility. Used where maximum strength in a carbon machinery steel is required or where untreated alloys of simpler type have been used.

**ELECTROMET**—Electro Metallurgical Sales Co., New York. A line of ferro-alloys and alloying elements of various analyses.

***See advertisement, Page 9-D***

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**ELECTRUNITE**—Steel and Tubes Division, Republic Steel Corp., Cleveland. Electric-welded tubing in stainless, carbon, copper bearing steel and rust-resisting copper molybdenum iron (Toncan). Square, rectangular, oval, or other shapes, in any size or gage where the periphery of the shape is not less than 2-1/32 inches or more than 16 inches. Used for general mechanical purposes.

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**ELKALOY**—P. R. Mallory & Co. Inc., Indianapolis. A work-hardened alloy of copper, not heat-treatable, for spot and seam welding aluminum and its alloys, unpickled hot rolled steel, terne plate, tin plate, galvanized iron and other materials. A direct substitute for copper, it handles the same but is harder and lasts longer.

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**ELKON BRONZE**—P. R. Mallory & Co. Inc., Indianapolis. Contains copper with small percentage of alloying ingredients. Furnished as castings only. Resists heat up to 930 degrees Fahr.; abrasion resistance, medium; tensile strength, ult., 55,000 lbs. per sq. in.; bearing properties, good; used for current carrying members in electrical machinery requiring higher strength and hardness than copper.

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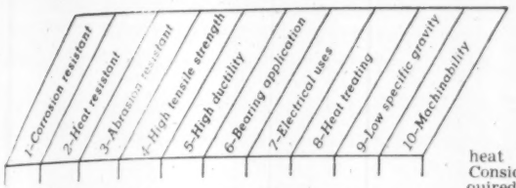
**ELKONITE**—P. R. Mallory & Co. Inc., Indianapolis. Two definite classes of materials. One group based on copper and such refractory metals as tungsten, molybdenum and their carbides—combinations which pro-




duce material with good electrical conductivity and great wear-resistant qualities, for use as welding electrodes and contactors in oil-immersed circuit breakers. Another group is based on silver and refractory materials such as tungsten, molybdenum and their carbides, and has been developed primarily as a facing material for heavy duty electrical contacts and contactors for air breakers. This material can be used either in the form of a thin facing or as an insert with copper or copper alloy backing material.

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**ELVERITE**—Babcock & Wilcox Co., New York. Special chilled iron castings; for tube mill lining, car wheels, jaw crushers, sprockets, etc.

*See advertisement, Page 65-D*

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**ENDURO**—Alloy Steel Div., Republic Steel Corp., Massillon, O. Stainless and heat resisting alloy.

Chromium-nickel group:

17-7; chromium 17, nickel 7, carbon .09-.20; used for automotive trim and for deep drawing where straight chromium types are not sufficiently ductile.

18-8; chromium 18, nickel 8, carbon cont. .08-.20; especially suited to resist atmospheric corrosion and corrosion reagents; for dairy and chemical plant equipment, food and meat processing machinery, high strength, light weight structural members, and for resistance to oxidation at elevated temperatures.

18-8-S; similar to 18-8 except carbon is kept under .08 which permits its use in welded equipment subject to severe corrosion.

18-8-FS; a special modification of 18-8 to develop greater softness and less work hardening; better adapted to successive drawing and spinning operations with less annealing than 18-8.

18-8-STi; 18-8-S to which titanium has been added for eliminating intergranular corrosion at high temperatures; used for airplane collector rings and exhaust manifolds, and other high temperature requirements.

18-8-SCb; 18-8-S plus columbium; for applications similar to those for which 18-8-STi is recommended. More efficient as carbide stabilizer and better corrosion resistance than titanium.

18-8-SMo; 18-8-S plus 2 to 3 molybdenum; resistant to acids encountered in paper and pulp processes, woolen dyeing and in chemical and pharmaceutical industries; recommended for severe corrosive conditions; good fabricating and welding properties.

18-8-P; 18-8 with 2 to 3 silicon; for resistance to oxidation in temperatures up to 1700 degrees Fahr.; for annealing boxes, furnace parts, etc.

18-8-FM; a free-machining type of 18-8 through addition of .07 min. selenium; machinability very good for chromium-nickel type—about 70 per cent that of screw stock. Corrosion resistance same or little less than 18-8.

19-9-SMo; a modification of 18-8-SMo with higher alloy content for applications requiring somewhat higher corrosion resistance than 18-8-SMo.

HCN; chromium 25, nickel 12; for resistance to oxidation up to 2000 degrees Fahr.; fabricates, machines, and welds readily. High strength and creep at elevated temperatures. Not recommended for high sulphur conditions at high temperatures.

HCN-Low Carbon; a variation of HCN with carbon .80 max. for applications involving welding and corrosion resistance to eliminate carbide precipitation.

NC-3; chromium 25, nickel 20, silicon 2 max.; for maximum heat resistance. Best strength and creep at high temperatures, but may be attacked if sulphur present in gases. Resistant to carburizing.

S-Turbine Quality; chromium 11.5-13, carbon .15 max. used for applications where corrosion resistance and physical strength are needed at medium high temperatures.

S-High Carbon; a straight chromium, high carbon grade for heat treating for high hardness applications.

Straight chromium group:

S-1; chromium 10-14, carbon .15 max., responds readily to heat treatment and is recommended where strength, toughness and hardness are required; for pump shafts, valve seats and stems, nuts and bolts, etc.

S-1 Nickel; a modification of S-1 with addition of 2 max. nickel for somewhat better physical properties than S-1.

FC; free machining grade of S-1 analysis. Machines nearly as well as screw stock. Fairly resistant to the atmosphere, organic and fruit acids, etc. Can be hardened by heat treatment up to about 400 brinell. Considerably more care and control required in forging operation than with S-1.

FC High Carbon; a high carbon variation of FC having better physical properties than FC.

AA; chromium 14-18, carbon .12 max.; good corrosion resistance and heat resistant to 1500 degrees Fahr.; general corrosion resistance, fabricating and welding properties inferior to 18-8; for bicycle fenders, oil burner parts, etc.

AA High Carbon; a variation of AA with somewhat better physicals.

AA-FM; a free-machining codification of AA with machinability about 85-90 per cent of Bessemer screw stock.

HC; chromium 23-30; heat resistant to 2000 degrees Fahr.; not affected by sulphur gases; strength and creep at high temperatures not as good as the chromium-nickels.

18-23; chromium 18-23; high heat resisting properties; good resistance to scaling, but strength and creep lower than chromium-nickel types; for furnace parts, etc.

4-6 per cent; chromium 4-6 with several carbon ranges to .25 and with or without addition of molybdenum or columbium, titanium, aluminum and tungsten; additions of columbium, titanium or aluminum practically eliminate air hardening on welding; corrosion and heat resistance considerably superior to that of carbon steels, and with fair strength at high temperatures; for oil refinery and furnace parts.

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**ERMAL**—(Z-Metal)—Erie Malleable Iron Co., Erie, Pa. A spheroidized pearlitic malleable cast iron; for castings requiring rigidity, high tensile strength, and abrasion resistance. Suitable for heat treatment.

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**ERMALITE**—Erie Malleable Iron Co., Erie, Pa. Wear-resisting alloy iron; for gears, wearing plates, friction drums and other parts subject to high stresses or wear.

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**EVERDUR**—American Brass Co., Waterbury, Conn.

Alloy No. 1010; copper 95.8, silicon 3.1, manganese 1.1; uses include tanks and sewage disposal apparatus.

Alloy No. 1015; copper 98.25, silicon 1.50, manganese .25; easily fabricated by all methods including welding; used for tubes, bolts and screws.

Alloy No. 1000; casting alloy; copper 94.9, manganese 1.1, silicon 4.

*See advertisement, Pages 17-D—20-D*

## F

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**FACEWELD**—Lincoln Electric Co., Cleveland. Coated type electrodes for hard-facing worn parts of straight carbon, medium carbon or manganese steel to resist severe abrasion and moderate impact.

No. 1 (yellow tip); deposits of single layer have hardness of 45-52 Rockwell C. Multiple layers have hardness of 52-58 Rockwell C. Toughness of this deposit is greater than that of No. 12.

No. 12 (red tip); single layer hardness is 52-57 Rockwell C. Multiple layer hardness is 55-59 Rockwell C.

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**FARRELL'S 85**—Farrell-Cheek Steel Co., Sandusky, O. Specially processed steel castings for resisting abrasion, and possessing high strength, toughness and rigidity; tensile strength up to 150,000 lbs. per sq. in.; used for parts subject to shock, high stress, overload, wear and abrasion.

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**FARRELL'S HARD EDGE**—Farrell-Cheek Steel Co., Sandusky, O. Furnished as sand castings; high abrasion resistance; high tensile strength and ductility; brinell hardness, heat treated 650-700 and higher; for crane wheels, cast tooth gears, rollers, sheaves, sprockets, traction wheels.

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**FEDERAL BRONZES**—Federal-Mogul Corp., Detroit.

F1; a gear bronze suitable for heavily loaded piston pin bushings, etc.

F2; lead bronze for average bushing application.

F3; used largely as backs for babbitt-lined bearings.

F5; widely used for babbitt-lined bearing backs and for bushings where service is not severe.

F6; for average bushing applications.

F8; good casting and machining qualities.

F11; for piston pin bushings and other low speed, heavily loaded applications.

F13; suitable for many of the uses to which F1 is applied.

F15; has 20 per cent lead and may be used safely under adverse lubrication conditions.

F16; because of high lead content may be used where only occasional lubrication is possible.

F18; high lead alloy of good casting characteristics.

F19; strong ductile alloy of average hardness with bearing qualities corresponding to other low lead compositions.

F20; a hard bronze used for gears and worm wheels where requirements are severe; also aluminum bronze and special analysis bronzes.

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**FERROWELD**—Lincoln Electric Co., Cleveland. For arc welding cast iron. Has steel base to give solid weld on cast iron of greater tensile strength than the cast iron itself. Due to low current which can be used, hardening effect usually present along the line of fusion is materially reduced.

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**FIRTHALOY**—Firth-Sterling Steel Co., McKeesport, Pa. Highly developed form of sintered carbide adapted to wire drawing dies, extrusion dies and similar purposes.

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**FIRTHITE**—Firth-Sterling Steel Co., McKeesport, Pa. Hard metal composition of sintered carbides furnished in number of grades to form wearing surfaces or the edges of cutting tools.

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**FIVEPOINT DEEPHARD STEEL**—Foote Brothers Gear and Machine Corp., Chicago. Nickel-molybdenum alloy, for hot forging, turning, boring, etc.; resists heat to 250 degrees Fahr. steady, and 300 degrees Fahr. intermit.; abrasion resistance, high; tensile strength, ult., 216,000 lbs. per sq. in.; ductility, high; bearing properties, good; for use where abrasion, erosion, fatigue and shock resisting qualities are desired.

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**FLAMALOY**—Detroit Alloy Steel Co., Detroit. Furnished as castings. Carbon .35-.45, manganese 1-1.25, chromium 1-1.10, copper .90-1, molybdenum .30-.45; medium abrasion resistance; tensile strength, ult., 130,000 lbs. per sq. in.; high ductility; recommended heat treatments approx. 1500 degrees Fahr. water quenched; brinell hardness, untreated 200, heat treated 630; for miscellaneous machine parts.

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**FLEETWELD**—Lincoln Electric Co., Cleveland. Shielded arc electrode for welding mild steel.

Type 5; for flat, vertical and overhead welding. Tensile strength, 65,000-75,000 lbs. per sq. in.; ductility, 20 to 30 elong. in 2 in.; impact resistance, 30-70 ft. lbs. (Izod); density 7.84-7.86 grams per c.c.; corrosion resistance greater than mild steel.

Type 7; for general purpose welding and where fit-up is not of the best; low spatter and slag loss, high burn-off rate. Physical properties as welded; tensile strength, 70,000-80,000 lbs. per sq. in.; yield point 55,000-66,000 lbs. per sq. in.; ductility, approximately 17 per cent elong. in 2 in.; specific gravity, 7.80.

Type 8; heavily-coated electrode of shielded arc type for fillet welding in down positions only. Capable of producing fillets, (one plate vertical), up to 3.8 in size in one pass. Tensile strength, 65,000-75,000 lbs. per sq. in.; yield point 47,000-63,000 lbs. per sq. in.; elong. 20 to 30 per cent in 2 in. Can be used with either alternating or direct current.

Type 9; heavily-coated electrode of shielded arc type specifically for flat welding of deep groove joints. Physical properties as welded; tensile strength, 66,000-74,000 lbs. per sq. in.; yield point, 55,000 to 60,000 lbs. per sq. in.; elong. 20 to 30 per cent in 2 in.; specific gravity, 7.85 to 7.86; operates either with d.c. or a.c.

Type 9-HT; heavy-coated electrode of shielded arc type for deep grove welding in flat position of high tensile steels.

Type 10; for downhand welding on flat surfaces for finish bead welding and to provide full slag coverage and smoothness. Can be used with either direct or alternating current normal or reverse polarity.

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**FRANKITE**—Frank Foundries Corp., Moline, Ill.

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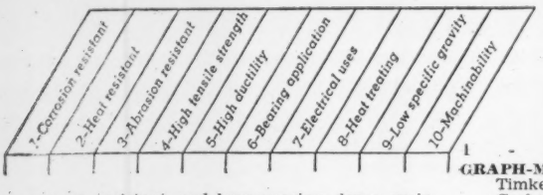
E-212; low carbon electric furnace iron; pres-




sure resistant and long-wearing dense grain in heavy sections; for hydraulic bodies, refrigerator parts, compressor cylinders, etc. Good machinability.

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E-450; nickel 14, chromium 2, copper 6, electric furnace Ni-Resist. For corrosion resistance, heat resistance to 1500 degrees Fahr.; machinability fair.

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E-604; nickel 4½, chromium 1½, electric furnace Ni-Hard white iron. Combats corrosion; for mixer blades, ash chutes, scrapers, grinding burs, etc.; machinability by grinding

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E-830-N; chromium 30, nickel 3, low carbon; heat resistant; for continuous oven kilns, cement kiln cooler parts, furnace supports, etc.; machinability fair.

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**FRONTIER**—Frontier Bronze Corp., Niagara Falls, N. Y.

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No. 40 Ti-Aluminum; aluminum-chrome-magnesium-titanium-zinc alloy; furnished in rough bars or billets, finished rods or bars, tubing, sheets, and as castings; resists corrosion caused by salt water; resists heat to 600 degrees Fahr.; abrasion resistance, high; tensile strength, ult., 35,000-40,000 lbs. per sq. in.; compressive strength, ult., 30,000-35,000; brinell hardness, untreated 90; for use where strength at high temperatures is required.

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No. 5 Alloy; copper-aluminum and iron alloy, furnished as castings; tensile strength, ult., 60,000-95,000 lbs. per sq. in; compressive strength, ult., 22,000-65,000 lbs. per sq. in.; ductility, medium; brinell hardness, untreated 130, heat treated 140-200; for parts where high fatigue is required.

## G

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**G ALLOY**—American Smelting & Refining Co., New York. Lead bearing alloy furnished in ingots for spinning and mold casting. Resists heat up to 300 degrees Fahr.; abrasion resistance, high; tensile strength, ult., 10,000 lbs. per sq. in.; compressive strength, ult., 15,000 lbs. per sq. in.; good bearing properties; brinell hardness, untreated, 22. Used for bearing applications.

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**GIBSILOY**—Gibson Electric Co., Pittsburgh, Electrical contacts having high ductility, good weldability and machinability.

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**GLOBE STAINLESS STEEL**—Globe Steel Tubes Co., Milwaukee. Seamless steel tubing furnished in common steels as well as most of grades of SAE alloys, and stainless or corrosion resisting steel.

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**GLYCO BABBITT**—Joseph T. Ryerson & Son, Inc., Chicago. General tradename covering a group of specially processed lead base alloys including:

Turbo-Glyco; for high speed, heavy-duty; average brinell hardness, 30.

Marine Glyco; for electric motor and marine work; average brinell hardness 27.

Standard Glyco; free flowing, general purpose; average brinell hardness 24

Heavy pressure mill Glyco; high resistance to crushing loads; average brinell hardness 23.

Transmission Glyco; for line shafting and transmission work; average brinell hardness, 22.

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**GRAMIX**—The United States Graphite Co., Saginaw, Mich. Bearing bronze; resists heat to 300 deg. Fahr.; tensile strength, 12,000 lbs. per sq. in.; compressive strength 100,000; specific gravity, 5.9-6.1 (apparent density); brinell hardness, untreated, 500 kilograms—28; used for bearings, contacts, slides and thrust bearings.

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**GRAPHITIC CARBON**—United States Graphite Co., Saginaw, Mich. Resists corrosion caused by most chemicals; resists temperatures up to 5000 degrees Fahr. in a reducing or neutral atmosphere; tensile strength, 5000 lbs. per sq. in.; compressive strength, 20,000 lbs. per sq. in.; used for special bearing and seal applications.

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**GRAPH-MO**—Timken Steel & Tube Div. The Timken Roller Bearing Co., Canton, O. Carbon 1.50, silicon .80, manganese .40 max., phosphorus and sulphur .025, manganese .025, molybdenum .25; furnished in hot-rolled bars or billets, finished rods or bars, seamless tubing, wire, strips, sheets and plates, for hot forging, stamping and welding into parts. Has high abrasion resistance; tensile strength, ult., 85,000 lbs. per sq. in., min.; medium ductility; fair bearing properties; good weldability; recommended heat treatments for annealing, normal 1600 degrees Fahr.; oil quenched, 1475-1550 degrees Fahr.; brinell hardness, untreated 197, heat treated 745. Used for sliding or rotational service.

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**GRAPHO**—Lehigh Babbit Co., Allentown, Pa. A homogeneous mixture of graphite and babbitt which can be poured in the usual way; recommended for bearings subject to lubricating difficulties.

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**GRAPH-SIL**—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O. Carbon 1.50, silicon .90-1, manganese .40 max., phosphorus and sulphur .025 max.; furnished in hot-rolled bars or billets, finished rods or bars, seamless tubing, wire, sheets, strips and plates, for hot forging, stamping, welding, turnings, boring, etc. Tensile strength, ult., 97,000 lbs. per sq. in., min.; abrasion resistance, high; medium ductility; good bearing properties and weldability; for use as cylinder liners and in sliding or rotational service.

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**GRAPH-TUNG**—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O. Carbon 1.50, manganese, .40 max., phosphorus and sulphur .025, max., silicon, .65, molybdenum .50, tungsten 3; furnished in hot-rolled bars or billets, finished rods or bars, wire, sheets, strips and plates, for hot forging, stamping and welding. Has high abrasion resistance; tensile strength, ult., 95,000 lbs. per sq. in., min.; medium ductility; fair bearing properties; good weldability; and brinell hardness, untreated 229, heat treated 840; used for sliding and rotational service.

## H

**HANDY FLUX**—Handy & Harman, New York. For brazing steel, stainless steel, monel metal, nickel, copper, beryllium-copper, brass, bronze, aluminum bronze and various other ferrous and nonferrous metals and alloys.

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**HARDTEM**—Heppenstall Co., Pittsburgh. Carbon .5, nickel-chrome-molybdenum die steel; for die blocks, shafting, etc.

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**HARDWELD**—Lincoln Electric Co., Cleveland. High carbon arc welding electrode having brinell of 225-488; provides dense, tough surface of moderate hardness to enable various steel parts to resist shock and abrasion; for locomotive or crane tire flanges, etc.

Type 50; medium carbon steel electrode for building up steel parts and surfaces. Deposit has considerable resistance to deformation and wear, and is machinable at slow speed. Coating stabilizes the arc and permits deposition of a tough, dense medium carbon steel. Hardness, deposited on straight carbon steel and allowed to cool naturally, 20 to 35 Rockwell C.

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**HARDY METAL**—Charles Hardy Inc., New York. Powdered metal compressed into parts; give most physical characteristics which are available from metal ore alloys produced by melting and casting. According to metal powders chosen, low or high Brinell hardness can be secured; used for manifolds. Depending also on powders chosen, all properties listed below can be obtained.

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**HASCROME**—Haynes Stellite Co., Kokomo, Ind. Chromium-manganese-iron composition welding rod for hard-facing parts subject to abrasion and impact, and castings to resist abrasion and impact.

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**HASTELLOY**—Haynes Stellite Co., Kokomo, Ind. Corrosion-resistant, nickel-base alloys for piping, tanks, pump parts, valves, vessels, A and B; nickel, molybdenum and iron; for resistance to hydrochloric acid.

C; nickel, molybdenum, chromium and iron; for resistance to wet chlorine, and oxidizing or reducing acid solutions.

D; nickel and silicon; for resistance to sulphuric acid, hot or cold.

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**HAYNES STELLITE 93**—Haynes Stellite Co., Kokomo, Ind. Ferrous alloy welding rod for hard-facing metal wearing parts; abrasion resistance, high; tensile strength, ult., 43,040 lbs. per sq. in. average; Rockwell hardness, untreated C-62, heat treated, average C-67.

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**HAYNES STELLITE**—Haynes Stellite Co., Kokomo, Ind. Nonferrous cobalt-chromium-tungsten alloys for corrosion and wear-resistant castings, metal-cutting tools, hard-facing welding-rod for parts subject to abrasion or a combination of abrasion, heat and corrosion.

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**HAYSTELLITE**—Haynes Stellite Co., Kokomo, Ind. Cast tungsten carbide; inserts, tube rod, and composite rod (welding) for hard-facing oil-well drilling tools, dredge cutter blades, etc.

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**HEPPENSTALL 2 C 30**—Heppenstall Co., Pittsburgh. Nickel-chrome-molybdenum steel, carbon .3; for shafting where high torsional strength is required such as drop hammer piston rods.

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**HEPPENSTALL 5 H 50**—Heppenstall Co., Pittsburgh. Carbon .5, chrome, molybdenum and vanadium alloy furnished as die blocks. Material is heat resistant, abrasion resistant, has high tensile strength and high ductility. Used also for strip mill rolls, etc.

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**HERCULOY**—Revere Copper and Brass Inc., New York.

419 and 421 (types B); silicon 1.5-2.25, either .25 tin or .35 manganese, balance copper; furnished in rods or bars, tubing, wire, sheets, strips (coiled) and plates, for hot forging, stamping, extruding, welding, deep drawing and cold forging; corrosion resistant; medium abrasion resistant; tensile strength, ult., 45,000-90,000 lbs. per sq. in.; high ductility; for cold-headed bolts, nuts, screws, nails and electrical hardware.

418 and 420 (types A); silicon 3, either .5 tin or 1 manganese, balance copper; furnished same as above; tensile strength, ult., 55,000-120,000 lbs. per sq. in.; high ductility; used for range boilers, and for applications requiring high strength in combination with good weldability and corrosion resistance of copper.

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**HI-GLOSS**—Jessop Steel Co., Washington, Pa. Type 304; stainless steel having ult. strength of 90,000 lbs. per sq. in.; yield point, 45,000 lbs. per sq. in.; elongation in 2 in., 60 per cent; weight per cu. in. .238 lbs.; brinell hardness, 150; used for pumps, airplanes; air conditioning, automotive, chemical, dairy, and restaurant equipment, etc.

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**HIPERNIK**—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. A magnetic alloy consisting of 50 per cent nickel and 49 iron; extremely ductile; developed for special magnetic properties at moderately low induction, primarily for radio applications; also used for transformer laminations; melting point is 1450 degrees Cent.; sometimes used for heater elements for high temperature furnaces with reducing atmospheres.

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**HOYT BABBITT METAL**—National Lead Co., New York. Analysis according to bearing application.

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**HUBBARD SPECIAL**—Continental Roll & Steel Foundry Co., East Chicago, Ind. Nickel chrome steel for applications such as wear-resisting rolls, guides and other miscellaneous castings.

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**HYLASTIC**—American Steel Foundries, Chicago. Carbon .35, manganese 1.50, vanadium .10-.12, phosphorus and sulphur not over .05; also furnished with the addition of chromium where greater resistance to abrasion is desirable; tensile strength, ult., 95,000 lbs. per sq. in.; used for rolling mill machinery, automotive and railroad equipment, hammer mills and hydraulic machin-

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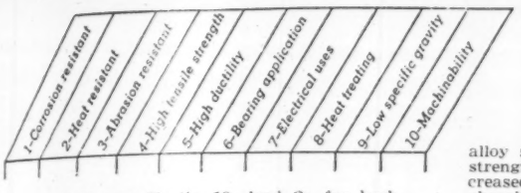
**HY-SPEED**—Buckeye Brass & Mfg. Co., Cleve-




land. Copper 88, tin 10, lead 2; for bushings, bearings, bars.
***See advertisement, Page 25-D***

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**HYTEMCO**—Driver-Harris Co., Harrison, N. J. Alloy of nickel and iron characterized chiefly by its high temperature coefficient of electrical resistance; lends itself advantageously to uses requiring self regulation by temperature such as immersion heaters.

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**HY-TEN**—Wheelock-Lovejoy & Co. Inc., Cambridge, Mass. Chrome-manganese-molybdenum and chrome-nickel-molybdenum alloys with carbon from .10-1; for machine parts.

## I

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**IDEALOY**—Wellman Bronze & Aluminum Co., Cleveland. Copper-tin-zinc alloy for heavy duty bearings.

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**ILLIUM**—Burgess-Parr Co., Freeport, Ill.

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G: nickel 58, chromium 22, copper 7, molybdenum 4-6, balance iron, tungsten and manganese; brinell hardness 170-220; for pumps, meters, chemical equipment and other parts subject to corrosion; resists heat to 1500 degrees Fahr.; resists most corrosion solutions except chlorides and other halogens; used for parts subject to corrosion in rayon and chemical industries.

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R: nickel 58, chromium 21-23, copper 0-4, molybdenum 4-6, balance iron, tungsten and manganese; brinell hardness 175-240 annealed, and up to 365 work-hardened; resists most corrosive solutions except those containing chlorides and other halogens; resists heat to 1200 degrees Fahr.; tensile strength 90,000-105,000 lbs. per sq. in. annealed and 140,000-150,000 upon work hardening; used for parts subject to corrosion in rayon and chemical industries.

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**INCONEL**—The International Nickel Co. Inc., New York. Nickel 79.5, iron 6.5, copper .2, manganese .25, silicon .25, carbon .08, chromium 13, sulphur .015; corrosion resistant, high mechanical properties, resistant to heat up to 2000 degrees Fahr.; used for high temperature applications and equipment for handling food and chemical products.
***See advertisement, Page 63-D***

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**INDUSTRIAL**—Industrial Steels Inc., East Cambridge, Mass.
Stainless Steel, No. 35; chrome 13-14, carbon .30-.40. No. 65; chrome 16-17, carbon .60-.70. No. 100; chrome 17-18, carbon .9-1.
Stainless Iron, No. 12; chromium 11.5-13. No. 18; chromium 16-20. No. 512; chromium 11.5-13, .12 carbon, .3-.4 sulphur, balance iron. No. 188; chromium 17-20, nickel 8-10. No. 5188; chromium 17-20, nickel 8-10. No. 188 SMO; chromium 17-20, nickel 8-10, molybdenum 2-4 per cent.

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**INGACLAD**—Ingersoll Steel & Disc Div., Borg-Warner Corp., Chicago.
Stainless clad steel consisting of a layer of 18-8 chrome nickel, Type 304, also 18.8 columbium stabilized and 18-8 molybdenum bearing, stainless layer bonded to a layer of ordinary steel; uses include equipment for chemical, food, dairy, processing, brewery, packing house, bottling industries, etc.; suitable for applications requiring stainless steel protection on one surface.

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**INGERSOLL**—Ingersoll Steel & Disc Div., Borg-Warner Corp., Chicago. Stainless steel furnished in sheets for stamping and welding into parts; resists heat up to 1200 degrees Fahr.; abrasion resistance, medium; tensile strength, ult., 85,000 lbs. per sq. in.; ductility, high; brinell hardness, annealed, 165.

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**INLAND**—Inland Steel Co., Chicago.

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Copper bearing steel; used largely for sheets; copper minimum .20.

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Silico-manganese spring steel.

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Hi-Steel, high strength, high ductility low alloy steel for applications where increased strength and corrosion resistance with decreased weight is desired. A copper-nickel-phosphorus alloy steel.

## J

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**J & L CORRECT BALANCE (Forging Steel)**—Jones & Laughlin Steel Corp., Pittsburgh. Furnished in rough bars or billets, finished rods or bars, and plates, for hot forging. Tensile strength, compressive strength, ductility, weldability, and heat treatments are as specified. Used for any carbon steel parts made from forgings.

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**JSB**—Johnson Bronze Co., New Castle, Pa. Bronze on steel in finished bearings; medium abrasion resistance; bearing properties, good; used for bushings, bearings, washers, etc. Also babbitt on steel and babbitt on bronze bearings, bronze bearings and bushings, bronze castings.
***See advertisement, Page 28-D***

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**JALCASE**—Jones & Laughlin Steel Corp., Pittsburgh.

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Low carbon open hearth steel which offers machinability practically equivalent to Bessemer screw stock plus the added advantage of rapid case carburizing properties; manufactured as S.A.E. X1314 and S.A.E. X1315 in .10 to .20 carbon grades.

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Open hearth steel which in the higher carbon ranges offers exceptional heat treating qualities combined with forging properties and good machinability; manufactured as S.A.E. X1330 (.25-.35 carbon), S.A.E. X1335 (.30-.40 carbon) and S.A.E. X1340 (.35-.45 carbon).

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**JESSOP**—Jessop Steel Co., Washington, Pa.

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Nonmagnetic steel; furnished in rough bars or billets, finished rods or bars; sheets and plates; medium abrasion resistance; tensile strength, 80,000-110,000 lbs. per sq. in.; medium ductility; specific gravity, 8.02; fair bearing properties; good weldability; brinell hardness, untreated 180, annealed, 150; used for transformer covers, controller covers, switch covers, spacing bars, end fingers, etc.

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Heat resisting steels, in No. 4, 5 and 5-B grades; No. 4 has ult. strength 95,000 lbs. per sq. in., yield point 50,000 lbs. per sq. in.; used for castings, marine submarine and torpedo parts, oil engine valves, pump shafts, etc. No. 5 has ult. strength of 100,000 lbs. per sq. in.; yield point 45,400 lbs. per sq. in.; used for pump parts, etc. No. 5-B applications are similar to No. 5, but No. 5-B has superior resistance to corrosion, and is more easy to fabricate. No. 5-B is similar in physical properties to No. 5 except that its tensile strength is greater.

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**JOHNSON**—Johnson Bronze Co., New Castle, Pa.
No. 27; copper 80, tin 10, lead 10; deoxidized with phosphorus; general purpose bearing bronze.
No. 19; copper 70, tin 11, lead 19; high wear rating and resistance to pounding; for mill bearings, gas and diesel engines, excavating and pulverizing machinery, etc.
No. 25 (plastic bronze); copper 75, tin 5, lead 19, nickel 1; for high speed with light to medium loads and generally free from shock; because it has good acid resistance it is particularly suitable for pump bearings and sleeves, and also for electric motor, conveyor and fan, and woodworking machinery bearings.
No. 29; copper 78, tin 7, lead 15; for use where spindle is of soft steel and speed is relatively high; acid resisting alloy.
No. 53; copper 88, tin 10, zinc 2; for severe service or heavy pressures; should be used where shaft is hardened steel and well lubricated.
No. 72; copper 83, tin 7, lead 7, zinc 3; best suited for moderate speeds and low loads.
No. 10 (babbitt alloy); tin 90, antimony 5, copper 5; for thin linings and also may be used in die castings.
No. 11; tin 87, antimony 7, copper 6; rather hard babbitt recommended as lining for connecting rods and shaft bearings subjected to heavy pressures.
No. 12; tin 90, antimony 7.5, copper 2.5; for high speeds and high temperatures.
No. LX; lead 74.75, antimony 15, tin 10, copper .25; for camshaft bearings.
***See advertisement, Page 28-D***

## K

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**K-42-B**—Westinghouse Electric & Mfg. Co., East Pittsburgh. Nickel 45, cobalt 25, iron 8, chromium 20, titanium 2; furnished in rough bars or billets, rods or bars, wire, strips (coiled), and plates; for hot forging, stamping, turning, boring, welding, etc., also furnished as sand castings; resists corrosion caused by atmosphere and salt solutions; resists heat to 2000 degrees Fahr.; tensile strength, ult., 160,000 lbs. per sq. in.; nonmagnetic; brinell hardness, heat-treated 300-400; for applications where corrosion resistance, heat resistance, high strength at high temperatures are required.

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**KENNAMETAL**—McKenna Metals Co., Latrobe, Pa.
Type KWH; Cobalt 11, tungsten, tungsten-titanium, carbide, columbium carbide constituting balance; corrosion resistant, resists heat to 1200 degrees Fahr., high abrasion resistance; tensile strength (transverse rupture test) 220,000 lbs. per sq. in.; compressive strength 680,000 lbs. per sq. in.; specific gravity 10.5; good magnetic and bearing properties; for wear resisting guides, valves, nozzles, etc.
***See advertisement, Page 79-D***

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**KLEENKUT**—Heppenstall Co., Pittsburgh. Tool steel containing 2 carbon and 12 per cent chromium; for shear knives for cold shearing light material.

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**KONAL**—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Nickel 72, cobalt 17, titanium 2.2, iron 6.25; internal combustion engine valves, molds and machine parts which are subject to stress at high temperatures.

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**KOVAR**—Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Low expansion to 400 degrees Cent.; approximately 28.2 nickel, 18 cobalt, 53.8 iron; for gas-tight metal-to-glass seals on radio tubes and similar applications. Distributed by Stupakoff Laboratories, Pittsburgh.

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**KROKOLOY**—Detroit Alloy Steel Co., Detroit. Furnished in castings, chromium 12-14, carbon 1.5-1.6, cobalt 3-3.5, molybdenum .85-.90. Semiresistant to corrosion; heat to 1000 degrees Fahr.; abrasion resistance, high; tensile strength, ult., 125,000 lbs. per sq. in.; compressive strength, ult., 400,000 lbs. per sq. in.; medium ductility; good bearing and magnetic properties; used for high-speed bearings and cams, valve seats, etc.

## L

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**LEDALOYL**—Johnson Bronze Co., New Castle, Pa. Self-lubricating bearing bronze, pre-alloyed; contains lead which eliminates harshness and provides conformability for misalignment; combination of lead and graphite plus oil content make it useful where lubrication is remote or likely to be forgotten.
***See advertisement, Page 28-D***

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**LEDLOY STEELS 10**—Inland Steel Co., Chicago. Lead-bearing, free-cutting, open-hearth steel; contains about one-quarter per cent lead, which increases machinability about 30-50 per cent and tool life approximately 50-200 per cent, but has no appreciable adverse effect on physical properties of the steel.

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**LIGHTWELD**—Lincoln Electric Co., Cleveland. Arc welding electrode made for fabrication of chain and gear guards and other machine parts of light gage steel.

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**LO CRO**—Crucible Steel Co. of America, New York.
Type 501; stainless steel containing over .1 carbon, and 4-6 chrome.
Type 502; stainless steel containing .1 max. carbon, and 4-6 chrome.

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**LOTUS BABBITT**—Lumen Bearing Co., Buffalo. Lead base bearing babbitt.

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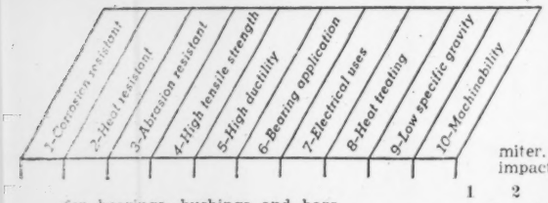
**LUBRICO**—Buckeye Brass & Mfg. Co., Cleveland. Copper 75, lead 20, tin 5 per cent;




for bearings, bushings and bars.

*See advertisement, Page 25-D*

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**LUKENS**—Lukens Steel Co., Coatesville, Pa.

2 per cent nickel steel; furnished in sheets, plates and spun and pressed heads; for hot forging, stamping, welding, riveting, turning, boring, etc., into many types of machine parts where a high-tensile steel of good ductility is required.

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Carbon-Molybdenum steel; furnished in sheets, plates and spun and pressed heads for hot forging, stamping, welding, riveting, turning, boring, etc.; for machine parts requiring a high-strength steel which retains its strength under conditions of elevated temperature operation.

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Abrasion resisting steel; furnished same as above, for use in a variety of parts requiring resistance to wear or abrasion.

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Gear rim steel; furnished same as above; abrasion and wear resisting; originally developed for use in rims of welded gear blanks, as well as other machine parts.

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Chrome-manganese steel; furnished same as above; tensile strength 100,000 lbs. per sq. in.; used principally in fan blades and fan rings.

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Chrome-copper-nickel steel; furnished same as above; tensile strength 65,000 lbs. per sq. in.; used where good resistance to impact is desired in parts operating in sub-zero temperatures.

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Manganese-vanadium steel; furnished in same as foregoing; high tensile steel with good welding properties, used in construction of antiaircraft gun mounts and carriages as well as military tank parts.

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Manganese-molybdenum steel; furnished same as foregoing; tensile strength 95,000 lbs. per sq. in.; for use in parts in which abrasion and high tensile strength is desirable.

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Nickel-clad, Super nickel-clad, Inconel-clad and Monel-clad steels are all clad metals or bi-metals consisting of light layer of corrosion resistant super-nickel, nickel, Inconel or Monel bonded to a heavier base plate of steel. All are corrosion resistant and are used in variety of machine parts where this property is desirable.

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**LUMEN ALLOYS**—Lumen Bearing Co., Buffalo. (Note: "Lumen Alloy," together with each of the following numbers and grades, is a copyrighted term which should be used in specifying these materials. Thus, "Lumen Alloy No. OOA," etc.)

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Nos. 00A and 00C; high tin bronzes for high compression bearing applications.

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No. 1; zinc bronze for pressure castings including spur and bevel gears mating with

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No. 2; zinc bronze for machine parts, bearings, etc.

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No. 3; zinc bronze for mine service and paper mill machinery and bearings.

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No. 4; phosphor bronze (leaded), for bearings.

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No. 4 chill cast; for heavy duty bearings, etc.

No. 4A; high phosphorus bronze (leaded), for bearings on hard steel.

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No. 5; general service casting alloy; red brass; for low pressure valve bodies, etc.

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No. 7; phosphor bronze; uses include trolley wheels and castings to be nickel or chromium plated.

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No. 9; maganese bronze for machine parts requiring strength, electrical conductivity, and high pressure.

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No. 11-C; (sand cast) aluminum bronze; for miter, bevel gears and bearings subject to impact.

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No. 11-C; (heat treated) tensile strength 65,000-100,000 lbs. per sq. in.; recommended where strength, corrosion and heat resistance are required.

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No. 14; zinc bronze, babbitt backing; for valve bodies, etc.

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No. 15; phosphor bronze; for worm wheels, bearings, etc.

No. 15 chill cast; for worm gears, nuts and bearings.

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No. 15A; phosphor bronze (slightly leaded); for worm wheels, bearings, etc.

No. 15-A chill cast; for heavy duty bearings and worm gear castings.

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No. 20; super-manganese bronze; for machine parts requiring extra strength.

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No. 27; (sand cast) aluminum bronze; for strength and corrosion resistance.

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No. 27; (heat treated) for extreme tensile strength and shock resistance.

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No. 31; for high-speed, low-duty bearings.

No. 33; for bearings, high speed, low duty.

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No. 43 (chilled); nickel tin bronze for bear- gears and nuts; abrasion resistant.

No. 43 (chilled); nickel tin bronze for bearings, worm gears and nuts with higher tensile strength than No. 43.

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No. 48; nickel phosphor bronze; for bearings used with hardened steel, worm wheels, etc.

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No. 48 chill cast; for bearings, worm gears, nuts, slippers, etc.

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No. 54; phosphor bronze (leaded) for bearings and worm wheels for intermediate service.

No. 54 chill cast; for bearings, worm gears, nuts, etc.

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Old Genuine Babbitt; high strength ingot babbitt for bearings.

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Cosmos Babbitt; ingot material for bearings.

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Bronze; a zinc base alloy for bearings.

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**LYNITE**—Aluminum Co. of America, Pittsburgh. Aluminum forged and cast products. Information on each of these will be found under ALCOA alloys.

## M

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**MCA-MOLYBDENUM** — Molybdenum Corp. of America, Pittsburgh. For use in steel and iron; gives toughness, strength, ductility and resistance to abrasion and improves fatigue value. Increases physical properties at elevated temperatures. Molybdenum steel is easily machined and welded.

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**MACHINEBRONZE**—Lumen Bearing Co., Buffalo. Zinc bronze; cored and solid bars for bearings.

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**MAGNOLIA**—Magnolia Metal Co., Elizabeth, N. J.

Antifriction metal; lead-tin-antimony plus special fluxes, furnished in ingots; tensile strength, ult., 15,000 lbs. per sq. in.; compressive strength, ult., 20,650 lbs. per sq. in.; bearing properties, good; brinell hardness, untreated 21.8; used for bearings.

Isotropic Die Cast bronze bar stock; copper 80, tin 10, lead 10, and other alloys to suit conditions; furnished in cored bars; resists corrosion caused by acids; resists heat to 900 degrees Fahr.; tensile strength, ult., 31,500 lbs. per sq. in.; compressive strength, ult., 15,000 lbs. per sq. in.; bearing properties, good; brinell hardness, untreated 70; used for bearings.

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**MALLIX**—National Malleable & Steel Castings Co., Cleveland. Pearlitic malleable iron; tensile strength 75,000 lbs. per sq. in., elongation 5 per cent; for grate bars for sintering machines, elevator buckets, screen plates for pan mills and other castings subjected to heat, abrasion and shock.

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**MALLORY**—P. R. Mallory & Co. Inc., Indianapolis.

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3 Metal: a copper-chromium-lithium alloy used extensively for spot, flash and seam welding cold-rolled steel, stainless steel, nickel alloys and Monel metal, silicon bronze alloys, zinc, nickel, silver and other materials employed in applications where a high strength, high conductivity material is required.

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53B Metal; copper base alloy furnished in castings only; tensile strength 60,000-70,000 lbs. per sq. in.; used for heavy-duty butt seam welding wheels, flash welding dies, bearings and current and heat-carrying members in electrical and other machinery.

73 Metal; rough and finished bars and sheets containing 95 per cent copper; resists sea water; 110,000-170,000 lbs. per sq. in. tensile strength; used for bearings and bushings, vibrator arms, springs, spring washers and electrodes for projection welding.

100 Metal; rough and finished bars containing 95 per cent copper; recommended for high loaded small gears, current-carrying bearings, springs and other details.

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**MANGANWELD**—Lincoln Electric Co., Cleveland. Arc welding electrode that produces deposit of austenitic manganese-nickel-molybdenum steel; suitable for hard facing austenitic manganese steel parts containing 11-14 per cent manganese, such as crusher parts, valves, turbine runners, pulverizer roll shafts, gathering and loading equipment.

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**MARTIN STEEL**—Detroit Alloy Steel Co., Detroit. Furnished as castings. Chromium 12-14, carbon 1.5-1.6, cobalt 1.25, molybenum 1.25; semiresistant; resists heat to 1000 degrees Fahr.; high abrasion resistance; tensile strength, ult., 115,000 lbs. per sq. in.; compressive strength, ult., 375,000 lbs. per sq. in.; medium ductility; good bearing and magnetic properties; brinell hardness, untreated 220, heat treated 600; for use as high speed bearings, cams, valve seats, spindles, etc.

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**MASSILLON**—Massillon Steel Casting Co., Massillon, O. Alloy cast steel, heat treated; for domestic, industrial and locomotive stoker worms.

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**MAURATH**—Maurath Inc., Cleveland. Alloy welding rods of many types; each type made especially for use with one of the leading varieties of stainless and heat-resisting steels and with coating of distinctive identifying color, also uncoated electrodes and those of special analyses.

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**MAX-EL**—Crucible Steel Co. of America, New York.

1-B; carbon .20, with high manganese and low molybdenum; excellent machining and uniformity in carburizing response; used for automobile parts, machine tool parts, gages, sprockets, etc.

2-B; carbon .40, manganese 1; used in "as rolled" condition for machine tool spindles, lead screws, racks, worms, piston rods, etc.

3½ for heat treated parts on machine tools, such as gears, arbors, spindles, etc.

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**MAYARI**—Bethlehem Steel Co. Inc., Bethlehem, Pa.

A; a nickel-chromium series of steels, corresponding to S.A.E. 31 XX series, suitable for heat-treated parts. Furnished in various carbon ranges for carburizing, water and oil-hardened parts.

B; a nickel-chromium steel furnished as bolts and sucker rods, having good atmospheric corrosion resistance combined with moderate strength, used in heat-treated condition.

R; a low-carbon, high-strength nickel-chromium-copper-phosphorus structural steel having good resistance to atmospheric corrosion. Used for structural purposes where weight reduction and corrosion resistance are desired.

XI; a nickel-chromium-vanadium steel furnished as sucker rods and having properties similar to Mayari B but having higher tensile strength and yield point with same ductility. Responds readily to normalizing without internal stresses.

1-Corrosion resistant | 2-Heat resistant | 3-Abrasion resistant | 4-High tensile strength | 5-High ductility | 6-Bearing application | 7-Electrical uses | 8-Heat treating | 9-Low specific gravity | 10-Machinability

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**MAZLO Magnesium Alloys**—American Magnesium Corp., Cleveland.

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AM240; aluminum 10, manganese .1, magnesium remainder. Used in sand and permanent mold castings for parts of portable equipment and moving machinery parts where light weight and strength is important.

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AM260; aluminum 9, zinc 1, manganese .1, magnesium remainder. Heat treatable alloy for sand and permanent mold castings. For moving parts on high-speed production equipment and wherever pressure tightness and good strength are needed. Improved salt water resistance.

AM265; aluminum 6, zinc 3, manganese .15, magnesium remainder. Used for high strength sand castings with good chemical stability.

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AM230; aluminum 10, silicon .7, magnesium remainder. Used for pressure die castings for parts requiring light weight and thin sections.

AM263; aluminum 9, zinc .6, manganese .1, magnesium remainder. Used for pressure die castings for lightweight parts in portable or fast moving equipment.

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AM57S and AM-C57S; aluminum 6, zinc 1, manganese .15, magnesium remainder. Used for extruded bars, tubes and rolled sheet for lightweight applications in general.

AM3S; manganese 1.2, magnesium remainder. Used for sheet, strip, extruded shapes, sand castings, and hammer forgings of moderate strength for uses requiring maximum salt water resistance. Suitable for fabricated articles such as aircraft oil tanks and cowlings.

AM52S; aluminum 3, zinc 1, magnesium remainder. Used for rolled sheet and extrusions of light weight. Good welding and forming characteristics and salt water resistance.

AM58S; aluminum 8, zinc .8, manganese .15, magnesium remainder. Used for hot press forgings for parts under stress especially for aircraft and aircraft engine applications.

AM65S, aluminum 3.5, tin 5, magnesium remainder. Used for hot press forgings of moderate strength and lightness.

***See advertisement, Page 69-D***

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**McGILL**—McGill Mfg. Co., Valparaiso, Ind.

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No. 1 McGill Metal; aluminum bronze alloy, suitable for pump liners, gears, corrosion resistant castings and parts requiring strength, toughness with minimum weight.

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No. 2; McGill silicon bronze; corrosion resistant; resists heat to 500 degrees Fahr.; medium abrasion resistance; tensile strength 95,000 lbs. per sq. in.; brinell hardness, untreated 160-180.

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No. 4 McGill bronze hydraulic pressure castings; finished casting tolerance of plus or minus .005.

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**MEEHANITE**—Meehanite Metal Corp., Pittsburgh, and licensees as listed hereunder. A sorbo-pearlitic iron containing silicon, manganese, phosphorus, sulphur and carbon, composition depending upon mixture and physical constitution as determined by service requirements; twenty-five grades, some of which can be heat treated, and flame hardened, each having a separate and distinct combination of physical properties; available in cast form; for machinery and miscellaneous castings.

Licensees include the following: American Brake Shoe & Fdy. Co., Mahwah, N. J.; Atlas Foundry Co., Detroit; Banner Iron Works, St. Louis; H. W. Butterworth & Sons Co., Bethayeres, Pa.; M. H. Detrick Co., Newark, N. J.; Farrel Birmingham Co., Ansonia, Conn.; E. Long Ltd., Orillia, Ont.; General Electric Co., Ontario, Calif.; Valley Iron Works Inc., St. Paul; Greenlee Foundry Co., Chicago; American Laundry Machinery Co., Rochester, N. Y.; Cincinnati Milling Machine Co., Cincinnati; Cooper Bessemer Corp., Grove City, Pa., and Mt. Vernon, O.; Crawford & Doherty Foundry Co., Portland, Oreg.; Florence Pipe Foundry & Machine Co., Florence, N. J.; The Newark Stove Co., Newark, O.; Fulton Foundry & Machine Co. Inc., Cleveland; General Foundry Mfg. Co., Flint, Mich.; Stearns-Roger Mfg. Co., Denver, Colo.; Hamilton Foundry & Machine Co., Hamilton, O.; Kanawha Mfg. Co., Charleston, W. Va.; Barnett Foundry & Machine Co., Irvington, N. J.; Henry Perkins Co., Bridgewater, Mass.; Pohlman Foundry Co., Buffalo, N. Y.; Rosedale Foundry & Machine Co., Pittsburgh; Warren Foundry & Pipe Corp., Phillipsburg, N. J.; Kinney Iron Works, Los Angeles; Koehring Co., Milwaukee; Marshall Stove Co., Lewisburg, Tenn.; Vulcan Foundry Co., Oakland, Calif.; Ross-Meehan Foundries, Chattanooga, Tenn.; Vancouver Engrg. Works, Vancouver, B. C.; Washington Iron Works, Seattle; Washington Machinery & Supply Co., Spokane, Wash.

***See advertisement, Page 93-D***

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**METALINE**—R. W. Rhoades Metaline Co. Inc., Long Island City, N. Y. Lubricating insert plugs of several diameters and lengths and in varied compositions for rendering bronze bearings and bushings oilless. Also bronze bearings complete in which Metaline plugs are inserted, furnished in form of finished bearings.

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**METALS DISINTEGRATING**—Metals Disintegrating Co. Inc., Elizabeth, N. J. Alloy, antimony, aluminum (grain), bismuth, brass, bronze, cadmium, chromium, copper, iron, lead, manganese, molybdenum, nickel, silicon, silver, solder, tin, titanium, tungsten and zinc metal powders, having properties such as elimination of machining, compositions impossible to obtain by conventional methods, high surface area, catalytic work, etc.

***See advertisement, Page 15-D***

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**MILL BRASS MIX**—E. A. Williams & Son Inc., Jersey City, N. J. Bearings, bushings and mill brasses.

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**MOGUL BABBITT**—Federal-Mogul Corp., Detroit.

Mogul alloy genuine babbitt; made from tin, antimony and copper, virtually lead free; hard tough alloy; high tensile strength; suitable for die-cast and hand-poured bearings; used for high-speed automobile and aircraft engine, steel and bronze back main and connecting-rod bearings, trucks, tractors, high-speed machinery, planers, and crossheads.

Mogul bearing metal; general all-purpose babbitt for repair and maintenance; for bearings requiring toughness; used for machinery bearings, stationary gas engines, paper mill, rolling mill, rubber plant and brick machinery.

407 nickel babbitt; varying slightly from Mogul genuine babbitt alloy; for applications where speed is fairly high and bearings are large, that is 1/16th-inch or more in thickness; used in woodworking machinery and other heavy duty types.

408 special babbitt (copper hardened); originally produced for electric railway armatures, now used for special bearing applications; has great durability and will stand up under hard wear; used in motor pumps, motor shafts, rock crushers and forming presses.

Duro antifriction metal; while softer and less tough than Mogul bearing metal (above), compares favorably with lead base general purpose babbitts; used for flour mill, laundry, canning and bottling machinery, pump packing, slow moving pullys and axle bearings.

Special "B"; a lead and antimony alloy; free of usual nonbearing ingredients; used for slow speed bearings of all kinds and heavy line shafting.

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**MOLYBDENITE** — Continental Roll & Steel Foundry Co., East Chicago, Ind. Special chrome-molybdenum-steel castings for mill pinions, guides and rolls.

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**MO-LYB-DEN-UM**—Climax Molybdenum Co., New York. An alloying element for use in steel and iron; imparts strength, toughness, ductility and resistance to abrasion; improves fatigue value, eliminates temper embrittlement, increases physical properties at elevated temperatures; molybdenum steel is easily welded and machined.

***See advertisement, Page 77-D***

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**MO-MANG**—American Manganese Steel Div., The American Brake Shoe & Foundry Co., Chicago Heights, Ill. Manganese 12-14, carbon .7-.9, with molybdenum; welding rod for building up manganese steel and other ferrous castings.

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**MO-MAX**—The Cleveland Twist Drill Co., Cleveland. A high speed steel, furnished in rough bars or billets, finished rods or bars, wire and sheets, for hot forging, turning, boring, welding, etc.; resists heat up to 1100 degrees Fahr.; high abrasion resistance; high tensile strength; good bearing properties; specific gravity about 7.95; good weldability; brinell hardness, untreated 220, heat treated 700; for use where great strength and wear resistance up to temperatures of 1000 degrees Fahr. are required such as gears, cams, guides, wearing plates, etc. Licensees are: Bethlehem Steel Co., Braeburn Alloy Steel Corp., Carpenter Steel Co., Crucible Steel Co. of America, Henry Disston & Sons Inc., Halcomb Steel Co., Jessop Steel Co., Latrobe Electric Steel Co., Ludlum Steel Co., Universal-Cyclops Steel Corp., Vulcan Crucible Steel Co., Simonds Saw & Steel Co., and Columbia Tool Steel Co.

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**MONEL**—The International Nickel Co. Inc., New York. Nickel 67, copper 30, iron 1.4, manganese 1, silicon .1, carbon .15, sulphur .01; general purpose corrosion resistant, high strength, rustproof alloy; used for applications requiring protection against chemical reaction, high mechanical properties or attractive appearance.

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K Monel; Nickel 66, copper 29, iron .9, manganese .4, silicon .50, carbon .15, sulphur .005, aluminum 2.75; heat treatable alloy affording corrosion and abrasion resistance plus mechanical properties comparable to those of heat-treated alloy steels; nonmagnetic; for parts requiring corrosion resistance with high mechanical or nonmagnetic properties.

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R Monel; Nickel 67, copper 30, iron 1.7, manganese 1.1, silicon .05, carbon .1, sulphur .035; for parts requiring corrosion and abrasion resistance combined with free-cutting qualities permitting high-speed automatic machine work.

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S Monel; Nickel 63, copper 30, iron 2, manganese .9, silicon 4, carbon .1, sulpur .015; high-strength, corrosion and abrasion resistant material for castings requiring extra hardness for resistance of galling and seizing.

***See advertisement, Page 63-D***

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**MORAINE**—Moraine Products Div., General Motors Corp., Dayton, O. Rolled bronze split-type bearings and bushings for automobiles, electric motors and farm implements.

***See advertisement, Page 26-D***

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**MORGANITE**—Morganite Brush Co. Inc., Long Island City, N. Y. Carbon-graphite, and carbon-graphite-metal mixtures; furnished in finished rods or bars and plates, for turning, boring, molding, etc.; resists corrosion caused by any liquid handled industrially; resists heat to 700 degrees Fahr.; good abrasion resistance; tensile strength, ult., 1000-3000 lbs. per sq. in.; compressive strength, ult., 10,000-30,000 lbs. per sq. in.; ductility, low; specific gravity 2-2.15; used for bearings, valves, seals, nonfriction slides, piston rings, etc.

***See advertisement, Page 75-D***

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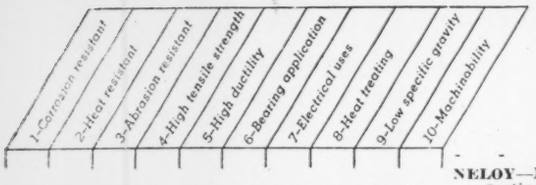
**MRCO METAL POWDER**—Metals Refining Co., Hammond, Ind. Metal powders furnished in the following grades:

40 RL; copper 99.4; all passing a 40-mesh sieve, not over 20 per cent passing a 200 mesh screen; has apparent density of 2.5 grams per cu. cm.; used in commutator brushes, chemical porous filters, catalyzers, and pressed metal compositions.

100 RXA; copper 99.4; all passing a 100-mesh screen; not over 45 per cent passing a 325-mesh screen; has apparent density of 2.7 grams per cu. cm.; used in porous metal bearings, intricate pressed metal shapes, electrical commutator brushes, etc.

150 RXA; copper 99.4; all passing a 150-mesh sieve, not over 75 per cent passing a 325 mesh sieve; has apparent density of 2.7 grams per cu. cm.; for same applications as 100 RXA.

200 RL; copper 99.4; all passing a 200 mesh sieve, and not less than 85 per cent passing a 325 mesh sieve; used in chemical equipment, special commutator brushes, small






pores in porous bearing compositions; also has advantages for copper brazing and coating welding rods.

500 RL; copper 99.4; all passing a 325 mesh sieve, and substantially all particles are less than 15 microns in dia.; for use where extremely fine particle size is desired, in brazing and coating, also as clutch facings, etc.

100 A; iron 96; all passing a 100-mesh sieve, not over 40 per cent passing a 325 mesh sieve; has apparent density of about 2.5 grams per cu. cm.; for pressed parts such as gears, filters, catalyzers, pressed ferrous metal compositions; electromagnets, etc.

300 A; iron 96; all passing a 300-mesh sieve, with substantially all particles less than 15 microns in dia.; used in parts such as radio cores, etc.

8 AC; iron 96; all passing an 8 mesh and retained on a 100 mesh sieve; used in filter plates, etc.

100 B; lead 99.7; all passing a 100-mesh sieve, not over 70 per cent passing a 325-mesh sieve; has apparent density of 5.6 grams per cu. cm.; used in brake linings, metallic clutch facings, porous bearings, filters, etc.

F; lead 99.7; all passing a 200-mesh sieve and substantially all particles less than 20 microns in dia.; used for same applications as 100 B.

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**MUELLER 600 BRONZE**—Mueller Brass Co., Port Huron, Mich. Copper 60, zinc 35, other ingredients 5. Bearing alloy for worm gears, connecting rods, seal rings for refrigerators, crankshafts for oil pumps, etc. Has high strength and corrosion resistance, especially resistant to sulphur compounds.

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**MUMETAL**—Allegheny Ludlum Steel Corp., Pittsburgh. Furnished in sheets, coiled strips and laminations for stamping, forming and drawing. Nickel 71-76, copper 4.5-6, chromium 2 max., balance iron. Has high permeability qualities; recommended heat treatment, 1800-2000 degrees Fahr. in stream of pure dry hydrogen; used for audio-transformers, sensitive relays and electrical instruments.

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**MUREX**—Metal & Thermit Corp., New York A series of welding electrodes designed for welding mild steel carbon-molybdenum steel U.S.S. Cor-Ten and Mayari, Cromansil, nickel steels, chrome-molybdenum, chrome-nickel, straight chrome, manganese, and high carbon steels and for building up and hard surfacing.

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**N-A-X HIGH TENSILE**—Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Detroit. Carbon .10-.18, manganese .60-.75, silicon .65-.9, copper .25 max., chromium .5-.65, nickel .1-.25, molybdenum .15 max., zirconium .1-.15, sulphur .04 max., phosphorus .04 max.; furnished in rough bars or billets, finished rods or bars, sheets, strips and plates; corrosion resistant; resists heat to 700 degrees Fahr.; medium abrasion resistance; tensile strength 75,000-85,000 lbs. per sq. in.; high ductility; good bearing properties and weldability; brinell hardness, untreated 149-156, heat treated 230-375; used for machine parts where high torsional properties, high tensile strength and resistance to fatigue and notch impact at normal and sub-zero temperatures are required.

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**NA, NA-1, NA-2**—National Alloy Steel Division, Blawnox, Pa. Varying percentages of nickel and chromium.

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**NACO**—National Malleable & Steel Castings Co., Cleveland. Specially processed cast steel; for service where heavy blows and constant friction require a material that combines great strength, toughness and resistance to wear; used in chains for steam shovel, dragline, draft gears, railway equipment.

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**NATIONAL NO. 6**—National Malleable & Steel Castings Co., Cleveland. High-strength steel furnished in castings. Has medium abrasion resistance, tensile strength, ult., 100,000 lbs. per sq. in., average; can be flame hardened; brinell hardness, heat treated, 200; used for automotive and other medium size castings requiring high strength and good machinability.

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**NELOY**—National-Erie Corp., Erie, Pa. Steel castings, rough, finished, machined or flame hardened; high strength and hardness due to combination of alloying and special hardening; high abrasion resistance. Used for various applications in rolling mills and steel works equipment, overhead traveling cranes, power shovels, drag lines, and other heavy machinery.

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**NICHROME**—Driver-Harris Co., Harrison, N. J. Acid and alkali, heat resistant alloy consisting of nickel 60, iron 25, chromium 15; resists heat to 2000 degrees Fahr.; recommended for furnace parts, acid dipping baskets, and filter screen.

A; nickel 62, chromium 15; heating element material; also for electrical devices including rheostats, potentiometers, seamless tubing, etc.

B; as an addition to cast iron; sold in ratios of 5 and 2½ parts of nickel to 1 part of chromium.

V; nickel 80, chromium 20; heating element material; also in sheets for welded tubing.

Cast Nichrome; for furnace parts, pyrometer protection tubes, conveyor castings and carburizing containers. Sheet Nichrome S; sheet; nickel 27, chromium 15, used for various applications.

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**NICKEL**—International Nickel Co. Inc., New York.

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Nickel; Nickel 99.4, copper .1, iron .15, manganese .2, silicon .05, carbon .1, sulphur .005; rustproof, corrosion-resistant chemical parts and where corrosion resistance is desired.

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D Nickel; Nickel 95.2, copper .05, iron .15, manganese 4.5, silicon .05, carbon .1, sulphur .005, a metal similar to nickel but affording superior mechanical properties and resistance to atmospheric attack at elevated temperatures.

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Z Nickel; Nickel 98; heat treatable material resembling nickel except for its higher mechanical properties which are comparable to those of oil-tempered spring steel; used for products requiring spring properties coupled with corrosion resistance.

***See advertisement, Page 67-D***

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**NICKELCHROMEWELD**—Lincoln Electric Co., Cleveland. Heavily coated electrode of shielded arc type for welding of Inconel, Nichrome and other similar alloys of 70-80 per cent nickel, 11-15 per cent chromium and 5-10 per cent iron.

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**NICKELOID**—American Nickeloid Co., Peru, Ill., Nickel bonded to zinc, latter serving as rustproof, flexible and inexpensive white metal base. Available in variety of brilliant finishes and patterns, as sheets, flat strips and coiled strip for continuous feed automatic presses. Can be supplied with quick removable, gum-adhered paper covering permitting drawing and forming without marring pre-finish. For tube clips, toys, automotive details and stamped and formed parts demanding bright, permanent finish.

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**NICUITE**—A. W. Cadman Mfg. Co., Pittsburgh. Nickel bronze; tin 10, nickel 3.5, zinc 2.5, trace of phosphorus, balance copper; high compressive strength for slow or medium speed operation under extreme pressures.

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**NI-HARD**—International Nickel Co. Inc., New York, and licensees. Nickel 4.5, chromium 1.5, total carbon 2.7-3.6; cast iron for chilled rolls, grinding balls, mill liners, etc., where abrasion is encountered.

***See advertisement, Page 67-D***

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**NILVAR**—Driver-Harris Co., Harrison, N. J. A 36 per cent nickel steel having the lowest coefficient of expansion to 392 degrees Fahr. of an alloy; used for thermostatic controls in heating apparatus such as electric ovens, laboratory ovens, gas ovens, oil burners, and house heating apparatus.

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**NIPERMAG**—Cinaudagraph Corp., Stamford, Conn. Nickel-aluminum-iron alloy furnished as sand castings; resists corrosion; specific gravity, 7; fair weldability; hardness on Rockwell C scale from 48-53, variable on account of crystal structure; for permanent magnets only.

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**NI-RESIST**—International Nickel Co. Inc., New York and licensees. Nickel 14, copper 6, chromium 2, total carbon 2.60-3.10, silicon 1.25-2, manganese 1-1.5; for castings handling corrosive waters and other solutions, or heats above the range of temperature where ordinary cast iron gives good service; resists corrosive vapors, gases and liquids; recommended instead of plain cast iron under such conditions.

***See advertisement, Page 67-D***

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**NIREX**—Driver-Harris Co., Harrison, N. J. Acid-resisting material with tensile strength, annealed, up to 95,000 lbs. per sq. in.; spring temper 180,000; supplied in finished rods or bars, wire, sheets and strip; also can be fabricated by sand casting; for use where corrosion and heat resistance, and spring properties will be useful.

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**NI-TENSYLIRON**—International Nickel Co. Inc., New York, and licensees. Nickel 1-4, total carbon 2.50-3.15, silicon 1.20-2.75, manganese .5-.9; for machine tool castings, diesel engine housings, auto cylinder blocks, pistons, etc.

***See advertisement, Page 67-D***

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**NITRALLOY**—Nitralloy Corp., New York, controls nitriding process and licenses under which alloy is produced. A chromium-molybdenum-aluminum steel capable of developing extreme hardness through nitriding; for cams and camshafts, gears, pump parts, spleened shafts, cylinder liners, etc. Licensees include Allegheny Ludlum Steel Corp., Bethlehem Steel Co., Crucible Steel Co. of America, Firth-Sterling Steel Co., Republic Steel Corp., The Timken Roller Bearing Co., Vanadium Alloys Steel Co., Copperweld Steel Co., and Atlas Steels Ltd.

***See advertisement, Page 11-D***

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**NUREX**—National Malleable & Steel Castings Co., Cleveland. A chromium-manganese-carbon alloy furnished in castings; resists corrosion caused by dilute aqueous solutions and acids (except phosphoric); resists heat to 1700 degrees Fahr.; abrasion resistance, high; ductility, low; used for mill balls, lining and similar purposes.

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**OFHC**—Scomet Engineering Co. (subsidiary of The American Metal Co. Ltd.), New York. Copper 99.985 per cent, oxygen free; furnished in rough bars or billets; resists heat to 1500 degrees Fahr.; medium abrasion resistance; tensile strength 65,000 lbs. per sq. in.; high ductility; specific gravity 8.93; excellent electric properties; brinell hardness, untreated 30-120. Used for electrical conductors of all kinds, tubing, strips, plates.

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**OHMALOY**—Allegheny Ludlum Steel Corp., Pittsburgh. Furnished in sheets, coiled strip, wire and rods, for stamping, turning and boring. Chromium 12-14, aluminum 4-4.75, balance iron. Has high electrical resistivity; magnetic properties moderate; resists oxidation to 2000 degrees Fahr. Anneals at 1350-1450 degrees Fahr. Used for electrical resistor grids and wire wound resistors, also edge-wound strip resistor.

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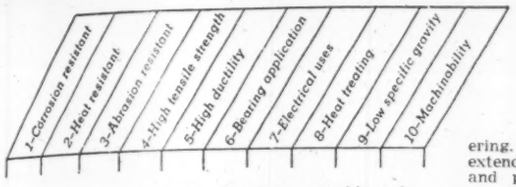
**OILITE**—Chrysler Corp. Amplex Div., Detroit, Mich. Oil cushion, heavy-duty bronze bearings containing one-third oil by volume; used extensively in automobiles, airplanes, farm implements, textile machinery, conveyors, air conditioners, machine tools, household equipment, electric motors, pumps, special machinery, clocks, etc.

Super-Oilite; a porous oil cushion extreme pressure self-lubricating bearing permitting an allowable bearing load of 50,000 lbs. per sq. in. under zero velocity; furnished as finished parts or in bars, plates, and irregular shapes; good bearing properties; high porosity oil cushion; high strength and ductility; self-lubricating; used for aircraft controls, landing gear, automotive parts, locomotives, tractors, farm implements, pumps, etc.

Super-Oilite "16"; a porous oil cushion extreme high pressure self-lubricating bearing with an allowable bearing load of 100,000 lbs. per sq. in. under static load; has high oil content, extreme hardness with an allowable bearing load exceeding 100,000 lbs. per sq. in. under zero velocity, and excellent bearing qualities; for use on heavy duty




equipment requiring bearings capable of carrying extreme loads.

Iron-Oilite; a porous pure iron self-lubricating bearing, oil impregnated; copper free, porous oil cushion bearing; resists corrosive effects of sulphur, its compounds and similar agents; used for bearings in pumps.

Aluminum-Oilite; a porous lightweight self-lubricating oil impregnated bearing; porous; eliminates galvanic action with surrounding aluminum housings often discovered with bearings which form a galvanic cell with aluminum; used for bearings for aircraft controls, and wherever lightness is important.

NDHTC-Oilite; a ferrous, nonporous high density material used for parts and shapes; tensile strength, ult., 80,000 lbs. per sq. in.; readily machined; heat treatable; high magnetic properties.

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**OLYMPIC BRONZE**—Chase Brass & Copper Co., Waterbury, Conn.

Type A; copper 96, silicon 3, zinc 1; tensile strength, 55,000-150,000 lbs. per sq. in.; brinell hardness 70-200; annealed at 1100-1200 degrees Fahr. if necessary to soften for additional cold working; resists corrosion due to saline, acid and alkaline solutions; used for welded structural parts, bolts, nuts, tubing, tie rods, etc.

Type B; copper 97.5, silicon 1.5, zinc 1; tensile strength, 45,000-90,000 lbs. per sq. in.; annealed at 1100-1200 degrees Fahr. if necessary to soften for additional cold working; resists corrosion due to saline, acid and alkaline solutions; used for bolts, nuts, pipe and tubing.

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**ORFIDE**—Scovill Mfg. Co., Waterbury, Conn. Copper 90, tin .5, balance zinc; furnished in finished rods or bars, tubing, wire, sheets and strips (coiled); for stamping, turning, boring, etc., into machine parts; medium abrasion resistance; tensile strength, 95,000 lbs. per sq. in. (hard drawn or rolled); specific gravity, 8.8; bearing properties fair; electrical properties fair; recommended heat treatments, anneal at 975-1025 degrees Fahr.; spring properties good; used primarily for spring contacts and switch parts.

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**OXWELD**—Linde Air Products Co., The, New York.

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No. 1; welding rod for steel giving welds of high tensile strengths up to 70,000 lbs. per sq. in.

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No. 7; drawn iron welding rod giving welds where high tensile strength is not a factor.

No. 9; cast iron rod (round) for gray iron castings.

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No. 23; welding rod for cast aluminum and aluminum alloys, giving high tensile strength.

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No. 25M; bronze welding rod having brinell hardness of 96 and high tensile strength.

No. 28; a columbium bearing welding rod suitable for 18-8 stainless steel.

*See advertisement, Page 5-D*

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**PDCP COPPER (Oxygen free)**—Phelps Dodge Copper Products Corp., New York. Copper 99.98; furnished in finished rods or bars, tubing, wire and strip; for hot forging, stamping, extruding, turning, boring, welding, drawing, etc.; resists heat to 406 degrees Fahr.; tensile strength 33,000-60,000 lbs. per sq. in.; high ductility; for bus bar, distiller tubes, water tubing, magnet wire, bull ring wire, strip for forming, stamping, etc.

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**PMG METAL**—Phelps Dodge Copper Products Corp., New York. High-tensile silicon bronze having high strength and hardness, low coefficient of friction, resistance to impact, etc.; produced in form of rods, wire, tubing, strip, sheet, sand castings, die castings and centrifugal castings; used for pump shafting, rods, bolts, nuts and rivets, valve parts, gears, bearings, spindles and rigid conduit and electrical metallic tubing.

**PAINTGRIP**—American Rolling Mill Co., Middletown, O. Galvanized sheet iron or steel with special bonderized surface integral with zinc coating; for immediate painting after fabrication. Obviates acid etching or weathering. Phosphate film neutral to paint and extends paint life, greatly retarding flaking and peeling.

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**PERDURO**—The Jeffrey Mfg. Co., Columbus, O. High-strength malleable iron for sand casting; resists corrosion due to analysis and heat treatment; resists heat to 1100 degrees Fahr.; high abrasion resistance; tensile strength, 80,000 lbs. per sq. in.; used for cast chains for drive and conveyor service.

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**PERMITE**—Aluminum Industries Inc., Cincinnati. Following grades available as sand castings, gravity die castings and ingots.

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No. 1002; copper 10, iron 1.50, magnesium 40, balance aluminum; for pistons for automotive, pump and refrigeration service.

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No. 1010; copper 4, silicon 1, balance aluminum; for machine parts to resist shock; heat treatment is to soak at critical and quench in water, and reheat at 350 degrees Fahr. to desired properties.

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No. 1019; furnished in ingots and sand castings; silicon 5, copper 1.25, magnesium .50, balance aluminum; heat treatment, quenching in water; suitable for highly stressed parts including airplane engine parts.

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No. 2011; silicon 5, balance aluminum; for parts subject to atmospheric corrosion.

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No. 2021; magnesium 4, balance aluminum; for parts subject to salt water corrosion.

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**PHOS-COPPER**—Westinghouse Electric & Mfg. Co., East Pittsburgh. A brazing alloy manufactured in rod and strip form, containing 7 per cent phosphorus and balance copper; highly corrosion resistant; gives strong joints when used for brazing copper and copper alloys to each other.

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**PITTSBURGH STAINLESS STEELS** — Pittsburgh Steel Co., Pittsburgh.

Stainless steels of various chromium-nickel-carbon types; 301, a high tensile material; 302, for food and meat packing equipment; 303, chrome-nickel-selenium type for screw stock; 304, similar to Type 302, advantageous for welded parts; 308, for cold heading requirements; 309, for welding rods where creep strength at elevated temperatures is a factor; 321, an 18-8 material with titanium added, for airplane parts; 347, similar to Type 321 but with better corrosion resistance; 310, chrome-nickel alloy for welding rod applications and where heat resistance is required; 316, chrome-nickel-molybdenum, acid resistant, for chemical and textile industries; 317, similar to Type 316 but more corrosion resistant; 410, heat treating type for use where high tensile and high rockwell hardness are desired; 414, similar to Type 410 but with somewhat different physical properties; 416, best machining qualities of these stainless steels but with only fair corrosion resisting properties; 430, corrosion resisting and fabricating properties not as good as Type 302, particularly good for trim; 446, high resisting steel with reasonably high creep strength.

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**PLANEWELD**—Lincoln Electric Co., Cleveland. Shielded arc electrode for welding SAE 4130 and X4130 chrome-moly steels such as are widely used in airplane construction. For welding all positions.

Type No. 1; is intended for use on landing gears, tail wheel assemblies, etc. in metal thicknesses of .120-inch and up.

Type No. 2; is used for airplane tubing and similar construction of light gauges up to about 7/64-inch thickness. It gives a minimum of penetration. Slag is easy to remove.

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**PLATINUM-CLAD**—Baker & Co. Inc., Newark, N. J. Pure platinum welded to various base metals, furnished in sheet, tubing and wire. Resists corrosion caused by usual acids; medium abrasion resistance; good weldability; tensile strength, ductility, etc., are dependent upon properties of base metals. Used for tubing exposed to acids and for vessels subject to same.

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**PLURAMELT**—Allegheny-Ludlum Steel Corp., Pittsburgh. Combination of mild steel and stainless steel; furnished in sheets and plates; for stamping and welding; corrosion resistant; resists heat to 1500 degrees Fahr.; medium abrasion resistance; tensile strength approximately 65,000 lbs. per sq. in.; high ductility; good weldability; fair magnetic properties.

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**POMPTON**—Allegheny Ludlum Steel Corp., Pittsburgh. Carbon .95-1.05; for arbors, bushings, collets and lathe centers. Water hardening.

**POREX**—Moraine Products Div., General Motors Corp., Dayton, O. Filtering and diffusing material product of powder metallurgy in bronze, iron, and other metals; provides high flow rates, low flow resistance; used in lubricating systems, engines, burners, appliances, etc.

*See advertisement, Page 26-D*

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**PRECISION**—Precision Castings Co. Inc., Syracuse, N. Y.

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Type A-12; aluminum base alloy; silicon 12, balance aluminum; resists heat to 1000 degrees Fahr., tensile strength, 33,000 lbs. per sq. in.; specific gravity, 2.66; for general aluminum die casting uses.

Type ZN-5; Zinc base alloy; aluminum 4, copper 1, magnesium .04, balance zinc; tensile strength, 42,000 lbs. per sq. in.; compressive strength, 85,000; specific gravity, 6.71; brinell hardness, 75; for general die casting uses—automotive, washing machines, electrical equipment, etc.

Type ZN-6; Zinc base alloy; aluminum 4, magnesium .04, balance zinc; tensile strength, 36,000 lbs. per sq. in.; compressive strength, 60,000; specific gravity, 6.60; brinell hardness, 65; for automotive and electrical equipment, washing machines, and miscellaneous mechanical parts.

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A-50; Aluminum base alloy; silicon 5, balance aluminum; furnished as castings; resists corrosion caused by atmosphere, foods, etc., resists heat to 1000 degrees Fahr.; abrasion resistance, medium; tensile strength, ult., 29,000 lbs. per sq. in.; ductility, medium; for use where corrosion resistance and ductility are essential.

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A-54; Aluminum base alloy; silicon 5, copper 4, balance aluminum; furnished as castings; resists corrosion caused by atmosphere; resists heat to 1000 degrees Fahr.; tensile strength, ult., 32,000 lbs. per sq. in.; general aluminum die cast parts.

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**PROMAL**—Link-Belt Co., Indianapolis. Specially processed malleable iron having high yield and fatigue strengths; for resistance to mild corrosive attack can be furnished with copper content; can be hot dip galvanized without embrittlement and can be used in ovens and furnaces up to 1100 degrees Fahr.; uses include conveyor and drive chain links, bearing caps, rocker arms, sheaves, levers and other machine parts subjected to severe service.

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**PROMET**—The American Crucible Products Co., Lorain, O. Heat-treated bronze bearing metal having great compressive strength, low coefficient of friction, lubricating qualities; for bearings and wearing parts.

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**PYTHON**—Allegheny Ludlum Steel Corp., Pittsburgh. Carbon .85, vanadium .25; for chuck jaws, clutch pins and other parts requiring unusual wear and shock resistance. Water hardening.

## Q

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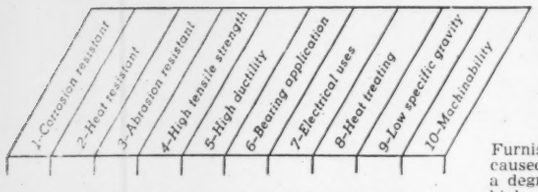
**Q-ALLOYS**—General Alloys Co., Boston.

CN-1; chrome 22-26; nickel 10-12; resists corrosion due to attack from most all common acids and gases; brinell hardness 160-200 untreated; resists heat to 2100 degrees Fahr.; tensile strength, 75,000-95,000 lbs. per sq. in.; used for machine part castings where corrosion resistance is desired.

CN-2; chrome 17-21, nickel 7-9; resists general corrosion; brinell hardness, 160-200 untreated, 160-200 heat treated; resists heat to 2100 degrees Fahr.; tensile strength, 70,000-80,000 lbs. per sq. in.; same use as above.

CN1-H; resists heat and corrosion; tensile strength, 80,000 lbs. per sq. in.; castings subject to temperatures to 2100 degrees Fahr.

CN1-MO; same data as for CN-1, except that it contains 1-4 per cent molybdenum.




CN2-MO; same data as for CN-2, except that it contains 1-4 per cent molybdenum.

Chrome C1; chrome 25-30, nickel 3 max.; resists corrosion caused by mine water.

Chrome C2; resists corrosion caused by nitric acid; used for machine part castings where corrosion resistance is desired.

Chrome C3; resists heat to 2000 degrees Fahr.; brinell hardness over 500 untreated; used for mill guides and any cast part requiring resistance to abrasion at high temperatures.

Grade A; resists heat to 2200 degrees Fahr.; nickel 65-68, chrome 15-19; tensile strength approximately 70,000-80,000 lbs. per sq. in.; annealing to remove casting stresses only; for machine part castings requiring high temperatures to 2200 degrees Fahr.

Grade B; approximately 60 nickel, 12 chromium; resists heat to 2200 degrees Fahr.; tensile strength, approximately 65,000-75,000 lbs. per sq. in.; for use where temperatures to 2200 degrees Fahr. are required.

## R

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**RANDALL**—Randall Graphite Products Corp., Chicago. S.A.E. No. 64 bronze or as specified; furnished as sand castings; resists corrosion caused by moisture; resists heat to 700 degrees Fahr.; high abrasion resistance; tensile strength, ult., 30,000 lbs. per sq. in.; medium ductility; good bearing properties; conductivity, good; brinell hardness, untreated 80; for use as bushings; graphite-inserted in the perforated or drilled hole, grooved, or reservoir types.

***See advertisement, Page 87-D***

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**READYWELD**—Lincoln Electric Co., Cleveland. Welding electrode for use with alternating current transformer type welders which have low open-circuit voltage. Possesses arc stability with easy re-striking. For general welding work on light gage sheet steel.

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**RED ANCHOR**—Anchor Drawn Steel Co., Latrobe, Pa. Carbon .95-1.1, commercial carbon drill rods; for precision shafts for motors, spindles, anvils and dental tools.

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**REPUBLIC**—Alloy Steel Div., Republic Steel Corp., Massillon, O. These alloy steels meet demands for material of lighter weight, greater strength, resistance to shock, impact and torsional strain, and high fatigue resistance; for severe service.

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**REPUBLIC DOUBLE STRENGTH** — Republic Steel Corp., Alloy Steel Div., Massillon, O. A low-alloy, copper-nickel-molybdenum steel with high tensile strength, excellent workability and resistance to atmospheric corrosion. Manganese .50-1, phosphorus .04 max., sulphur .04 max., copper .5-1.5, nickel .5-1.25, molybdenum .1 min., carbon in two ranges—Grade No. 1, .12 max., Grade No. 1-A, .3 max. Available in hot-rolled and cold-rolled sheets, hot rolled angles and formed sections; easily weldable, abrasion resistance. Used for lightweight construction.

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**REVALON**—Revere Copper & Brass Inc., New York. Copper 76, aluminum 2.25, arsenic .04, balance zinc; furnished in tubing and plates. In fabrication, material can be brazed, soldered or welded. Resists corrosion caused by high velocity, salt or brackish waters. Abrasion resistance, medium; tensile strength, ult., 55,000-80,000 lbs. per sq. in.; ductility, high; specific gravity, 8.31; bearing properties fair; used for condenser tubes for utility, oil refinery, marine, heat exchangers, etc.

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**REVERE CUPRO-NICKEL (30 per cent)**—Revere Copper & Brass Inc., New York. Copper 70, nickel 30; furnished as finished rods or bars, tubing, sheets, strips (coiled) and plates; for fabricating into parts by stamping, extruding, welding, deep drawing or cold forging. Resists heat up to 500 degrees Fahr.; abrasion resistance, medium; tensile strength, ult., 50,000-90,000 lbs. per sq. in.; ductility, high; specific gravity, 8.95; annealing range 1200-1600 degrees Fahr.; brinell hardness, hard, 140, soft, 70. Used for marine condenser tubes and condenser plate, cold-headed bolts and parts, etc.

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**REX Z METAL**—Chain Belt Co., Milwaukee. Furnished as castings; resists corrosion caused by weather and inorganic acids to a degree; resists heat to 1100 degrees Fahr.; high abrasion resistance; tensile strength, ult., 80,000 lbs. per sq. in.; medium ductility; specific gravity, 7.45; good bearing properties; brinell hardness, untreated 200; for cast parts requiring high strength and good machinability.

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**REZISTAL**—Crucible Steel Co. of America, New York. Stainless steels available in the following grades:

KA2, type 302; carbon over .08-.2, chrome 17.5-20; nickel 8-10, manganese 1.25 max.

2-C, type 302B; carbon over .08, chrome 17.5-20, silicon 2-3, manganese 1.25 max.

FM-188, type 303; carbon .02 max., chrome 17.5-20, nickel 8-10, sulphur or selenium .07 min., or molybdenum .6 max.

KA2S, type 304; carbon .08 max., chrome 18-20, nickel 8-10, manganese 2 max.

KA2S-2010, type 308; carbon .08 max., chrome 19-22, nickel 10-12, manganese 2 max.

No. 3, type 309; carbon .2 max., chrome 22-26, nickel 12-14.

No. 3S, type 309S; carbon .08 max., chrome 22-26, nickel 12-14.

No. 7, type 310; carbon .25 max., chrome 24-26, nickel 19-21.

No. 4, type 311; carbon .25 max., chrome 19-21, nickel 24-26.

KA2SMO, type 316; carbon .1 max., chrome 16-18, nickel 10-14, molybdenum 2-3.

KA2SMO, type 317; carbon .1 max., chrome 18-20, nickel 10-14, molybdenum 3-4.

KA2ST, type 321; carbon .1 max., chrome 17-20, nickel 7-10, titanium min. 4 X C.

2600, type 235; carbon .25 max., chrome 7-10, nickel 19-23, copper 1-1.5.

330; carbon .25 max., chrome 14-16, nickel 33-36.

KA2SCB, type 347; carbon .1 max., chrome 17-20, nickel 8-12, cobalt 10 x C.

Turbine, type 403; carbon .15 max., chrome 11.5-13.

No. 12, type 410; carbon .15 max., chrome 10-14.

No. 122, type 414; carbon .15 max., chrome 10-14, nickel 2 max.

FM2, type 416; carbon .15 max.; chrome 12-14, sulphur or selenium .07 min. or molybdenum .6 max.

Gr. A, type 420; carbon over .15, chrome 12-14.

No. 17, type 430; carbon .12 max., chrome 14-18.

No. 162, type 431; carbon .15 max., chrome 14-18, nickel 2 max.

Gr. B, type 440; carbon over .12, chrome 14-18.

No. 20, type 442; carbon .35 max., chrome 18-23.

No. 27, type 446; carbon .35 max., chrome 23-30.

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**RITA**—Cannon-Stein Steel Corp., Syracuse, N. Y.

No. 2; carbon .2, manganese 1.15, phosphorus and sulphur .05 max., nickel .5, chromium .3; brinell hardness, untreated 174, heat treated 388; carburizing 1650 degrees Fahr. and for toughening at 1550-1575 degrees Fahr.; resists corrosion due to chromium and nickel content; resists heat of 500-600 degrees Fahr.; tensile strength, 85,000 lbs. per sq. in. as rolled; for general machinery purposes where a free-cutting uniform material of great strength and toughness is desired.

No. 4; carbon .4, manganese .9, phosphorus and sulphur .08, chromium and nickel .5 max., brinell hardness, untreated 223, heat treated 461; recommended heat treatment, oil quenching, 1475 degrees Fahr.; resists corrosion due to chromium and nickel content, resists heat to 900 degrees Fahr.; tensile strength 105,000 lbs. per sq. in. as rolled. Recommended for spindles and shafts, toughness being reduced to render more readily machinable.

No. 5; carbon .5, manganese 1.2, phosphorus and sulphur .05 max., nickel .5 max., chromium .6; brinell hardness, untreated 269 heat treated 627, recommended heat treatment for oil quenching is 1500-1525 degrees Fahr.; resists corrosion due to chromium and nickel content; resists heat of 900-1000 degrees Fahr.; tensile strength, 130,000 lbs. per sq. in. as rolled; for gears, jaws, studs, bolts, axles, etc.

No. 7; carbon .65, manganese .5, phosphorus .045 max., sulphur .05 max., chromium .6, nickel 1.25; brinell hardness, untreated 179-223, heat treated 653; recommended heat treatment, water quenched, at 1425-1450 degrees Fahr.; oil quenched, at 1450-1475 degrees Fahr. Resists corrosion due to nickel and chromium content; resists heat of 700-800 degrees Fahr.; tensile strength, 135,000 lbs. per sq. in. as rolled; for expander and dowel pins, vise and wrench jaws, pneumatic hammer pistons, etc.

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**RIVERSIDE**—Riverside Metal Co., Riverside, N. J.

Beryllium copper; heat treatable copper alloy; has high tensile strength and ductility; for electrical parts, springs, diaphragms, jet tips, valve sleeves and seats, etc.

Phosphor bronze; copper tin alloy to which phosphorus has been added; has high strength and ductility; used in electrical appliances and machinery as springs, bearings, diaphragms, textile ring travelers, etc.

Nickel silver; copper, nickel, zinc in varying proportions; for diaphragms, radio and telephone springs, screw machine products, etc.

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**ROL-MAN**—Manganese Steel Forge Co., Philadelphia. Furnished in rods or bars, wire, sheets and plates, also hot forgings, stampings, wire cloth, welded and ground parts; contains manganese 11-14; carbon 1.1-1.4; resists heat to 400 degrees Fahr.; has high abrasion resistance; tensile strength, 140,000-160,000 lbs. per sq. in.; compressive strength 100,000; high ductility; nonmagnetic; brinell hardness, heat treated 190-210; used where abrasion resistance and high strength are needed; also for electrical uses.

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**ROMAN BRONZE**—Revere Copper & Brass Inc., New York. Copper 60, tin .75, zinc 39.25; for forging, flanging, upsetting; uses include piston rods, shafting, bearing applications, etc.

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**RUSTLESS**—Rustless Iron & Steel Corp., Baltimore.

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13-HC-35, type 420; carbon .4 max., chromium 12-14; hardening type of stainless steel; brinell hardness 550; used for valve parts, knife blades, abrasion and corrosion resisting machine parts.

17-HC-60 and 90, type 440; carbon .6-1.1, chromium 14-18; hardening type of stainless steel; brinell hardness 625; used for same type of machine parts as type 420.

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25-12, type 309; carbon .2 max., chromium 22-26; nickel 12-14; highly resistant to heat and creep to 1300 degrees Fahr., scaling to 2000 degrees Fahr.; resists nitric-sulphuric acid mixtures and sulphite liquors; used for furnace parts and for parts where corrosion conditions are severe.

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**RUSTLESS 17**—Rustless Iron & Steel Corp., Baltimore.

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Type 430; carbon .12 max. and chromium 14-18; resists sulphur gases, nitric, and organic acids; nonhardenable; for corrosion resisting rivets, screws, bolts and other parts.

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Type 430F; carbon .12 max., sulphur .15 min. and chromium 14-18; free-cutting stainless steel which resists heat to 1450 degrees Fahr.; tensile strength 100,000 lbs. per sq. in.

## S

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**SABECO**—Saginaw Bearing Co., Saginaw, Mich.

No. 5 bearing bronze; copper 69-71, tin 4.5-5.5, lead 24-26, max., impurities .2; for light or medium load and water lubricated bearings.

No. 9; copper 69-71, tin 8.5-9.5, lead 20-22, max., impurities .2; for heavy loads such as average machine tool requirements.

No. 11; copper 69-71, tin 10.5-11.5, lead 18-20, max. impurities .2; for extra heavy unit pressures.

No. 11HG; copper 69-71, tin 10.5-11.5, lead 18-20, max. impurities .2; for worm wheels, clutch shifter shoes, forging machine slides, and extreme heavy bearing conditions.

No. 16; copper 69-71, tin 15-16.5, lead 13.5-14.5, max. impurities .2; for friction rings, and heavy duty boring spindle bearings.

***See advertisement, Page 2-D***

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**SANDUSKY ALLOY IRON**—Sandusky Foundry & Machine Co., Sandusky, O. Nickel, chrome and molybdenum cast iron alloys; furnished in tubing, centrifugally cast and in finished cylindrical parts; resists corrosion; high abrasion resistance; tensile strength 25,000-60,000 lbs. per sq. in.; brinell hardness, untreated, 160-300; heat treated, 300-600; used for rolls, liners, sleeves, bushings, cylinders, pipes and tubes.

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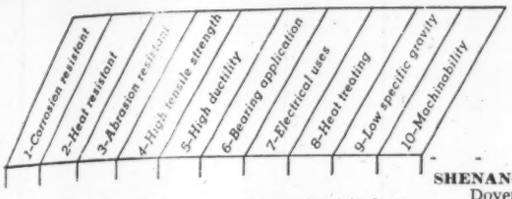
**SANDUSKY BRONZES**—Sandusky Foundry & Machine Co., Sandusky, O. Bronze, brass




and manganese bronze alloys; furnished in tubing, centrifugally cast and in finished cylindrical products; resists corrosion due to composition and superior structure; tensile strength 30,000-110,000 lbs. per sq. in.; good bearing properties; brinell hardness, untreated, 40-250; used for rolls, liners, sleeves, bushings, cylinders, pipe, tubes of 3-46 inches in diameter and up to 330 inches in length.

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**SCOVILL**—Scovill Mfg. Co., Waterbury, Conn. A complete line of high and low brasses, phosphor bronzes, nickel silvers, and cupro nickels for various mechanical, electrical and heat-exchanger purposes.

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**SCOVILL FREE-CUTTING BRASS ROD**—Scovill Mfg. Co., Waterbury, Conn. Copper 61, lead 3, zinc 36; furnished in finished rods or bars, for hot forging, turning, boring, etc. Resists heat to 500 degrees Fahr.; abrasion resistance, medium; tensile strength, ult., 55,000-75,000 lbs. per sq. in.; ductility, medium; specific gravity, 8.5; bearing properties, fair. Specially adapted to fabricating on high speed screw machines.

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**SCOVILL HARDWARE BRONZE**—Scovill Mfg. Co., Waterbury, Conn. Copper 89, lead 2, nickel 1, balance zinc; furnished in rods, bars and wire for turning, boring, etc.; machinability good; resists corrosion caused by atmospheric conditions; tensile strength, 38,000-85,000 lbs. per sq. in.; specific gravity, 8.85; bearing properties good; recommended heat treatment, annealing, 1000-1100 deg. Fahr.; brinell hardness, untreated, 48-125; used for hardware and screw machine products.

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**SCOVILL NAVAL BRASS**—Scovill Mfg. Co., Waterbury, Conn. Copper 60, tin .75, zinc 39.25; furnished in finished rods or bars, and tubing, for hot forging, welding, turning, boring, etc. Resists heat to 500 degrees Fahr.; medium abrasion resistance; tensile strength, ult., 60,000-90,000 lbs. per sq. in.; ductility, medium; weldability, fair; specific gravity, 8.4. Used for boat shafting, turn buckles, welding rod, etc.

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**SCOVILL Phosphorized Admiralty Metal**—Scovill Mfg. Co., Waterbury, Conn. Copper 70, tin 1, phosphorus .03, zinc balance; furnished in tubing; resists dezincification; resists corrosion caused by alkalis, weak acids, sulfur, petroleum compounds; resists heat up to 500 degrees Fahr.; abrasion resistance, high; tensile strength, ult., (soft) 50,000 lbs. per sq. in.; ductility, high; for condenser tubing, particularly where dezincification is to be expected.

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**SELFLUBE**—Keystone Carbon Co., Saint Marys, Pa. Self-lubricating porous bronze furnished in plates, bearings, sleeves spherical, etc. Resists corrosion caused by water, and heat up to 600 degrees Fahr.; abrasion resistance, low; tensile strength, ult., 11,000 lbs. per sq. in.; guaranteed 35,000 lbs. per sq. in. possible; compressive strength, ult., 70,000 lbs. per sq. in. possible; ductility, high; for bearings, bushings, etc.

*See advertisement, Page 79-D*

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**SEMINOLE**—Allegheny Ludlum Steel Corp., Pittsburgh. Carbon .45, chromium 1.3, tungsten 2, vanadium .25; for high creep strength bolts and studs for superheated steam; also machine parts having high wear and fatigue values. Withstands moderately elevated temperatures. May be oil hardened.

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**SHARON**—Sharon Steel Corp., Sharon, Penna. Stainless and heat resisting alloy. Chrome-nickel group 17-7, chromium 17, nickel 7, carbon .09-.020. Used for automotive trim for deep drawing where straight chromium types are not sufficiently ductile.

18-8; chromium 18, nickel 8, carbon 8-20; specially suited to resist atmospheric erosion and corrosion; for dairy and chemical plant equipment, food, meat, processing machinery, high strength, lightweight structural members and for resisting the oxidation of elevated temperatures.

Alloy steel, hot and cold rolled strip steel, hot and cold rolled sheet steel, Galvanite, galvanized, tin, terne and zinc coated strip and sheet, also available.

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**SHENANGO-PENN**—Shenango-Penn Mold Co., Dover, O. Centrifugal castings in all bronzes, Monel metals and alloy irons; used for bearings, bushings, drums, liners, roll covers, sleeves, washers, rings, etc.

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**SHIELD-ARC**—Lincoln Electric Co., Cleveland. Type 85; high tensile welding rod; recommended for fabrication of high tensile steels; brinell 190-250.

Type 100; brinell hardness 235-300.

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**SHOCK PROOF**—Lake City Malleable Co., Cleveland. Malleable iron of high tensile strength, high yield point and ability to withstand shock and abuse, possessing good machining qualities and resistance to corrosion.

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**SICROMO**—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O.

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Type 1; carbon .15 max., manganese .5 max., phosphorus .03 max., sulphur .03 max., silicon 1-1.4, chromium .75-1.25, molybdenum .45-.65; furnished in rough bars or billets, finished rods or bars, and tubing, for hot forging, welding, turning, boring, etc. Material is corrosion resistant; heat resistant to 1050 degrees Fahr.; tensile strength, ult., 60,000 lbs. per sq. in., min.; fair weldability; and brinell hardness, annealed 163 max. For use in oil refinery field.

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Type 2; similar to above with slightly more chromium content.

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Type 2½; similar to Type 2 with slightly different silicon content.

Type 3; similar to Type 2½, with slightly higher silicon and chromium content.

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Type 5; similar to Type 3, with lower silicon content and more chromium.

Type 5S; similar to Type 5, differing only in higher silicon content.

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Type 7; similar to Type 5S, having lower silicon and higher chromium content.

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Type 9; similar to Type 7, having higher chromium content. All above materials are for oil refinery use.

Type 7M; similar to Type 7, but having an increased molybdenum content.

Type 9M; similar to Type 9, but having an increased molybdenum content.

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**SIL-FOS**—Handy & Harman, New York. Brazing alloy containing silver 15, copper 80, phosphorus 5; furnished in rods, wire, sheets and strips (coiled); corrosion resistant; high ductility; specific gravity 8.45; used to join nonferrous metals only, particularly copper, brass and bronze.

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**SILFRAM**—Stoody Co., Whittier, Calif. A hard-facing metal designed for application to parts subjected to corrosion, abrasion and impact.

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**SILMO**—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O. Carbon .15 max., manganese .5 max., phosphorus .04 max., sulphur .045 max., silicon 1.15-1.65, and molybdenum .45-.65; furnished in rough bars or billets, finished rods or bars, and tubing, for hot forging, welding, turning, boring, etc., into parts. Tensile strength, ult., 55,000 lbs. per sq. in. min.; resists heat to 1000 degrees Fahr.; fair weldability; brinell hardness, annealed 163 max. For use in oil refinery field.

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**SILVER-PLY**—Jessop Steel Co., Washington, Pa. Stainless-clad steel in any desired analysis; furnished as sheets or plates for stamping and welding into parts; corrosion resistant; high abrasion resistance; tensile strength, average, 63,000 lbs. per sq. in.; high ductility and good weldability; used for heads, tank wells, lids and any part in which corrosion resistance is important.

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**SIMPLEX**—Crucible Steel Co. of America, New York. Nickel 1.25, chromium .75; forging steel for machine parts requiring high strength and toughness; also available in case carburizing type.

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**SIVYER**—Sivyer Steel Castings Co., Milwaukee.

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"Sixty"; chromium 18, nickel 8, carbon .12 max.; an austenitic nonhardenable corrosion resistant cast steel which is also non-magnetic.

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"Sixty-four"; chromium 27, nickel 10, carbon .25 max.; characterized by high strength and better corrosion resistance than "Sixty."

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"Sixty-six"; chromium 11.5-13.5, carbon .12 max.; hardenable cast steel of medium corrosion resistance.

Five per cent chrome moly—a 5 per cent chromium, .5 molybdenum steel, for oil refinery and power plant service.

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"Seventy"; chromium 15, nickel 35.

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Hi-carbon chrome-moly; a 70 per cent chrome molybdenum air hardening cast steel for severe abrasion; for rolling mill rolls, wearing plates, etc.

6140; fine grained cast chrome vanadium steel for road machinery or excavator teeth, etc., combining abrasion resistance with good ductility.

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3140; chrome-nickel general purpose steel; composition properly balanced for liquid quenching.

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Manganese nickel; manganese 1.2, nickel .75 suitable for differential water quenching.

Manganese vanadium; manganese 1.25, vanadium .1; cast steel with combination of strength and ductility.

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Dynamo; a low carbon, low manganese steel with low residual magnetism.

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**SOFTWELD**—Lincoln Electric Co., Cleveland. For arc welding cast iron where easy machinability is required.

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**STA-GLOSS**—Jessop Steel Co., Washington, Pa.

A, type 420; stainless steel; ult. strength, 230,000 lbs. per sq. in.; yield point, 220,000 lbs. per sq. in.; elongation in 2 inches, 2½; brinell hardness, 500; used for gears, pump rods, etc.

B, type 440; stainless steel; ult. strength, 280,000 lbs. per sq. in.; yield point 250,000 lbs. per sq. in.; brinell hardness, 580; used for engine parts, gages, etc.

C, type 440; stainless steel; ult. strength, 310,000 lbs. per sq. in.; yield point, 270,000 lbs. per sq. in.; brinell hardness, 600; used for valve seats, bearings, etc.

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**STAINWELD**—Lincoln Electric Co., Cleveland. Coated electrode for welding stainless steels or building up surfaces to resist corrosion.

Type A-5; for large number of so-called 18-8 stainless steels. Welds are of high tensile strength and ductility and possess same resistant qualities as the parent metal. Contains suitable amount of columbium to prevent intergranular corrosion of deposited metal.

Type A-7; for stainless steels of 18 per cent chromium, 8 per cent nickel type; fast-flowing, smooth operating; especially adapted for surfacing other steels with minimum admixture of base metal.

Type B; for arc welding stainless steel with chemical content of approximately 25 per cent chromium and 12 per cent nickel. Physical properties equal to metal welded.

Type C; a modification of the well-known 18-8 analysis, commonly known as 18-8 SMO (approx. 3½ molybdenum). Suitable for welding stainless steels of types 316-317 (Iron and Steel institute).

Type D; for stainless steels of 25 per cent chromium, 20 per cent nickel type; also for welding stainless steels to mild steel and for welding steels which are air-hardened and cannot be heat treated after welding.

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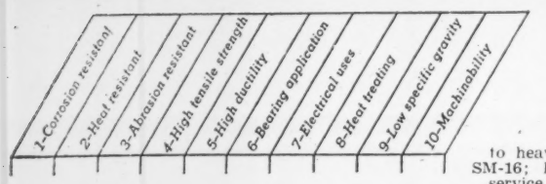
**STANDARD ALLOY**—Standard Alloy Co., Cleveland.

Type H.R. 6; chromium 25, nickel 12; for castings; corrosion resistant; heat resistance 2000 degrees Fahr.; high abrasion resistance; tensile strength 80,000 lbs. per sq. in.; high ductility; good weldability.

Type H.R. 3; chromium 15, nickel 35; for SM-18; lead 17½; for severe service; uses in castings; corrosion resistant; heat resistance 1850 degrees Fahr.; medium abrasion




resistance; tensile strength 70,000 lbs. per sq. in.; good weldability.

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**STANNUM BABBITT**—Lumen Bearing Co., Buffalo. Tin base bearing babbitt.

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**STERLING-NIROSTA Stainless Steels**—Firth-Sterling Steel Co., McKeesport, Pa.
Types KA2, KA2-FC, KA2S and 19-9; of the 18-8 chrome-nickel group containing approximately 18 per cent chromium and 8 per cent nickel with various modifications or additions to give special physical properties, machinability or resistance to certain corrosive action; the free-cutting type can be easily machined, and cold work-hardened wire and strip have great strength and resiliency.
Type FC (303); free-machining 18-8 steel.

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**STERLING Stainless Steels**—Firth-Sterling Steel Co., McKeesport, Pa.

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Type A (420); carbon .35, chromium 13.5; corrosion resistant; tensile strength 240,000 lbs. per sq. in.; for ball bearings and automotive parts subject to wear. Good physical properties in heat-treated state; maximum resistance to corrosion secured by hardening and through grinding.

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Type T (410); carbon .1, chromium 13; possesses maximum strength and elasticity without sacrifice of toughness; machinable and corrosion resistant; for pump rods, shafts, valve parts, gun barrels, pistons and machinery parts where strength is of greater importance than ease of machining.

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Type TX (403); modified Type T used for turbine blading.

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Type FC (416); free cutting stainless steel wherein a slight sacrifice in physical properties and corrosion resistance is made to obtain easier machining; for machine parts including screws, bolts, nuts, pump shafts, valves and spindles.
Type M (430); soft ductile steel that does not work-harden readily; requires no heat treatment to secure corrosion resistance.
Type MG (442); used where strength and toughness are secondary to workability and high temperature resistance.

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**STOODITE**—Stoody Co., Whittier, Calif. A hard-facing metal used chiefly as overlay on earth working equipment.

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**STOODITE (Numbered)**—Stoody Co., Whittier, Calif.; include Stoodite "45," "54" and "63," which range in physical properties from extreme hardness to extreme toughness. Rockwell "C" hardness indicated by numbers; designed for applications involving heat, impact or abrasion.

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**STOODY (Self-Hardening)**—Stoody Co., Whittier, Calif. A hard-facing metal used chiefly as an overlay on earth working equipment.

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**STRAINFREE ELASTUF**—Horace T. Potts Co., Philadelphia. Steel of manganese type without chromium, furnished in finished rods or bars; tensile strength 140,000 lbs. per sq. in.; medium ductility; nondistorting; high physicals; cold finished; brinell hardness, untreated 269. Used for parts whose length exceeds cross-sectional dimension as gears and worms with integral shafts.

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**STRESSPROOF**—La Salle Steel Co., Hammond, Ind. A modified SAE X1340 steel furnished in finished bars for machining; yield point 100,000 lbs. per sq. in.; and 90,000 lbs. per sq. in. depending upon the size; used for worm gears, lead screws, spindles, shafts and speed reducers.

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**SUMET**—Sumet Corp., Buffalo.
SM-4; lead 28 per cent; for light and medium duty bearings in high-speed service.
SM-8; lead 26; for moderately severe service.
SM-10; lead 24; for bearings subject to shock and impact.
SM-12; lead 22; for slow speed under heavy load and impact.
SM-14; lead 14; for severe service subjected to heavy shock.
SM-16; lead 20; for heavy duty slow-speed service.
clude roll neck bearings; also suitable for gear blanks.
SM-22; lead 10; for extremely severe heavy-duty service; abnormal loads.

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**SUMMERILL**—Summerill Tubing Co., Bridgeport, Pa. Seamless tubing in practically all regularly used carbon grades from SAE 1010 to SAE 1.00. Others are chrome molybdenum SAE 4130X, 4140, 4150, 4185, 52,100, 4340; nickel silver, pure nickel silver, corrosion resistant steels—18-8, 16-13-3 and similar grades; 4 to 6 per cent chrome with ½ moly; also some of 12-14 per cent chrome. Used for mechanical specialties, aircraft, industrial control instruments, fuel injection tubing for diesel engines, etc.

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**SUPERIOR STAINLESS**—Superior Steel Corp., Carnegie, Pa.

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Type 410; chromium 10-14, carbon .15 maximum.
Type 430; chromium 14-18, carbon .12 maximum.

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Type 301; chromium 16-18, nickel 7-9, carbon .09-.2.
Type 302; chromium 18-20, nickel 8-10, carbon over .08-.2.

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**SUPERLOY (Bulldog Brand)**—Phelps Dodge Copper Products Corp., New York. Copper 88, tin 2, zinc 10; furnished in tubing for extruding and drawing; resists heat to 400 degrees Fahr.; specific gravity 8.78; tensile strength, 75,000 lbs. per sq. in. for condenser tubes.

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**SUPERMAL**—The Jeffrey Mfg. Co., Columbus, O. High strength malleable iron; resists heat to 400 degrees Fahr.; high abrasion resistance; tensile strength 70,000 lbs. per sq. in.; medium ductility; brinell hardness, heat treated, 180-200; used for cast chains for drives and conveyor service.

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**SUPERTEMP**—Bethlehem Steel Co., Bethlehem, Pa. A patented alloy steel having high strength at high temperatures; suitable for bolts and studs for reaction chambers, cracking stills, superheaters, etc.

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**SURFACEWELD**—Lincoln Electric Co., Cleveland. A fine-grained alloyed powder for application with the carbon arc. Gives smooth abrasion resisting surface. Can be applied in thin layer. Properly applied, coating will have a hardness of 54 Rockwell C. Maintains hardness and resists scaling at high temperatures. Corrosion resistance comparable to stainless steel.

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**T-1 ALUMINUM**—The National Bronze & Aluminum Foundry Co., Cleveland. Copper 1.5-2.25, tin 1.25-1.75, magnesium .5-1, zinc .5-1.25, tin .1-.25, chromium .1-.3, iron 1 max., balance aluminum; furnished as finished castings or in rough bars or billets and ingots for sand casting; corrosion resistant; resists heat to 1100 degrees Fahr.; high abrasion resistance; tensile strength 30,000 lbs. per sq. in., min.; high ductility; good bearing properties; for use in parts where light weight and high strength are needed.

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**TALIDE**—Metal Carbides Corp., Youngstown, O. Tungsten carbide metal; resists corrosion due to high tungsten content; heat resistant to 2000 degrees Fahr.; high abrasion resistance; tensile strength 300,000 lbs. per sq. in.; specific gravity 14.1; brinell hardness, untreated, 130 and over; for use as wear plates and guides, cutting tools, drawing dies and bushings.

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**TAMCO**—Titanium Alloy Mfg. Co., Niagara Falls, N. Y. Alloys including original high and medium carbon ferro carbon-titanium, foundry ferro titanium, and several varieties of low carbon ferro titanium for rolled, cast and forged steels, stainless and alloy steels, and gray cast iron. For the nonferrous field, alloys include TAM Webbite (alumino-titanium) for aluminum castings, cupro-titanium for copper, nickel-titanium, molybdenum-titanium, and special alloys for special purposes, in addition to metallic titanium and metallic zirconium.

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**TEMP ALLOY**—Continental Roll & Steel Foundry Co., East Chicago, Ind. Chrome alloy heat resisting cast iron used for furnaces and other designs subject to high temperatures and abrasion.

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**TEMPALOY**—American Brass Co., Waterbury, Conn. Copper, aluminum and nickel alloys which yield to heat treatment; abrasion resistant; uses include motor boat shafting, piston rods, bearing application, etc.
***See advertisement, Pages 17-D—20-D***

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**TETON**—Alleghery-Ludlum Steel Corp., Pittsburgh. Carbon 1, chromium 1.4; for balls and ball races, bushings, cams, etc. Usually hardened in oil.

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**THOMASTRIP**—Thomas Steel Co., Warren, O. Cold-rolled strip steel, bright finish uncoated and electro-coated in brass, bronze, nickel, zinc and tin.

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**TI-COPPER NO. 39**—Frontier Bronze Corp. A copper-chromium-titanium-silicon alloy furnished as castings; tensile strength, ult., 43,000-45,000 lbs. per sq. in.; compressive strength, ult., .001 at 23,000-25,000 lbs. per sq. in.; ductility, medium; nonmagnetic; brinell hardness, untreated 30-40, heat treated 100-120; for use in welding machines.

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**TIGERLOY**—Massillon Steel Casting Co., Massillon, O. Nickel-molybdenum; for shovel castings, gears, crane track wheels, castings for impact resistance, etc.

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**TIMANG**—Taylor-Wharton Iron & Steel Co., High Bridge, N. J. Nickel manganese steel; can be rolled, drawn, forged or shaped; for journal box liners, pedestal gib liners, conveyor flights, welding rod, etc.

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**TIMKEN**—Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O.

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Type 17-22A; carbon .3-.35, manganese .5 max., chromium 1-1.5, molybdenum .45-.65, vanadium .25-.35, furnished in rough bars or billets, and finished rods or bars, for hot forging, turning, boring, etc. Heat resistant to 1200 degrees Fahr.; tensile strength, ult., 200,000 lbs. per sq. in., min., heat treated; medium ductility; and brinell hardness, untreated 200, heat treated 470 max. Used for bolts, studs and other highly stressed parts at elevated temperatures.

1 2 - - - - - - - - -
Type 18-8; carbon .07 max., manganese .20-.70, silicon .75 max., chromium 17-20, nickel 8-10. This austenitic nonmagnetic alloy shows very good combination of creep and rupture strength, oil corrosion resistance, and oxidation resistance for service up to 1500 degrees Fahr.

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Type 16-13-3; carbon .13 max., manganese 1.5 max., chromium 15.5-17, nickel 12.5-14.5, molybdenum 2.5-3.25. This molybdenum modification possesses higher creep and rupture strength than the standard 18-8 analysis and is also more resistant to certain types of corrosion, especially those associated with pitting.
Type 4-6 Cr.Mo.; carbon .15 max., manganese .5 max., silicon .5 max., chromium 4-6, molybdenum .45-.65. For service up to 1200 degrees Fahr. where corrosion resistance to hot petroleum products is a primary requirement. Inferior in its oxidation and corrosion resistance to Sicromo 5S.

2 - - - - - - - - -
Type .05 Mo. Steel; carbon .1-.2, manganese .3-.6, silicon .5 max., molybdenum .45-.65. For temperatures up to 1000 degrees Fahr. the satisfactory creep strength allows for greater safety than can be obtained from carbon steel. The oxidation and corrosion resistance, however, is similar to that of carbon steels.

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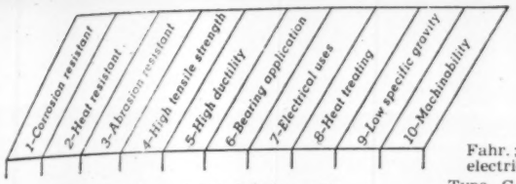
**TIOGA**—Allegheny Ludlum Steel Corp., Pittsburg. Carbon .67, manganese .6, chrome .65, nickel 1.4, molybdenum .2; combines good degree of hardness and toughness with fair nondeforming quality; oil hardening; used for lathe centers, clutch parts, rivets, cams,




arbors, spindles, gears, shafts, etc.

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**TISCO**—Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

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Stainless steel castings of all compositions, including chrome-molybdenum, nickel-chrome-molybdenum, 18-8 chrome-nickel, and high chromium.

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Manganese steel castings for shock and abrasion resistance. Used primarily for rock crushers, ball mill liners, sprockets, etc.

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**TOBIN BRONZE**—American Brass Co., Waterbury, Conn. Copper 60, zinc 39.25, tin .75; abrasion resistant; uses include piston rods, boat shafting, cordenser head plates, welding rods, seamless tubes, etc.

*See advertisement Pages 17-D—20-D*

1 - 3 4 5 - - 8 - -

**TOLEDO ALLOY**—Unitcast Corp., Steel Casting Div., Toledo, O.

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No. 3; carburizing steel, heat treated to give good machinability and uniform grain; excellent results obtained with short cycle carburizing treatment.

No. 4; abrasion resistant silicon-molybdenum steel with good hardening properties; used for mining tools, wear plates, crusher plates and pinions.

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No. 6; air hardening die steel of uniform machining qualities; long life under severe wear.

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No. 7; triple heat-treated manganese vanadium steel for many applications in the railroad and locomotive industry where extensive and repeated stress is encountered.

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No. 8; pearlitic manganese steel with analysis adjusted to give high tensile strength and ductility; used in automotive and aircraft equipment and other machines. Adaptable to flame hardening for selective treatment and oil hardening for complete quenching treatment.

No. 131; carbon .22-.28, manganese .7-.8, copper 1-1.2, vanadium .04-.08, silicon .4-.5 furnished in castings; tensile strength 90,000-100,000 lbs. per sq. in.; high ductility; for use where high strength and ductility are required and when hardness is of lesser importance.

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No. 135; Carbon .4-.5, manganese .75-.85, chromium .9-1.1, copper 1-1.15, molybdenum .25-.35; furnished as castings; resists corrosion caused by copper; abrasion resistance, medium; tensile strength, ult., 120,000 lbs. per sq. in.; ductility, high; weldability, good; brinell hardness, untreated, 217-241, heat treated, 600; for use in parts requiring high strength, guides, etc.

*See advertisement, Page 91-D*

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**TONCAN IRON** — Republic Steel Corp., Cleveland. An open-hearth iron alloyed with .4 min. copper and .07 min. molybdenum; resists corrosion caused by atmosphere, water, oils and process materials; tensile strength, 48,000-58,000 lbs. per sq. in. min.; compressive strength 40,000; brinell hardness 90-120; for housing, piping, tubing, etc. Also enameling stock, available in sheet form.

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**TOOLWELD** — Lincoln Electric Co., Cleveland. Coated arc welding electrode providing a deposit with hardness of 683-71 brinell; hardness retained to 1000 degrees Fahr.; deposit can be heat treated same as high-speed steel; for building hard, tough cutting edges on cold rolled steel and for other applications requiring super-hardness.

Type 55; for making metal cutting edges where shock is encountered (for cutting tools, blades and dies) providing an as deposited weld metal hardness without heat treatment of 55-60 Rockwell C. While not quite as hard as Type 60, it is somewhat tougher and more shock resistant. Otherwise, properties are essentially the same as Type 60.

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**TOPHET**—Wilbur B. Driver Co., Newark, N. J. Type A; approximately 80 per cent nickel and 20 chromium; resists heat to 2100 degrees Fahr.; supplied in wire and strip form for electrical heating applications.

Type C; nickel, chromium and iron; resists heat to 1900 degrees Fahr.; supplied in wire and strip form; for electrical resistance and heating applications; heat resistant.

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**TRANSWELD**—Lincoln Electric Co., Cleveland. Heavily-coated electrode of shielded arc type for welding of steel in all positions with A.C. current; tensile strength 80,000-85,000 lbs. per sq. in.

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**TRANTINYL**—Youngstown Alloy Casting Corp. Youngstown, O. Furnished as sand castings. High abrasion resistance; medium ductility; high tensile strength; used for tools for tube and bar mills such as guide shoes, plugs, guides, etc.

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**TRODALOY No. 1**—General Electric Co., Schenectady, N. Y. Resistance welding electrode alloy containing 2.6 per cent cobalt, .4 beryllium, 97 copper; has 55 per cent conductivity of copper; 45,000 lbs. per sq. in. proportional limit; 220 brinell hardness; used for switch blades, cams, spring fingers, etc. All sales made through following licensees: P. R. Mallory Co., Ampco Metal Co., Electroloy Co., and Welding sales & Engrg. Co.

*See advertisement, Page 16-D*

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**TRUALOY**—True Alloys Inc., Detroit.

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Copper; has high conductivity; castings for welding machines and conduction of current.

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Bearing bronze; low friction and wear, with high compressive strength; resistant to pounding and easy to machine.

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Aluminum; castings possessing high tensile strength, hardness and lightness.

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Aluminum bronze; for sand castings having corrosion resistance and tensile strength of 65,000 lbs. per sq. in.; recommended for parts subject to strain and wear.

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**TRUFLEX Thermostatic Metals**—General Plate Co., Attleboro, Mass. Furnished in sheets, strips and finished parts; can be stamped, welded and coiled; recommended heat treatments are 300-1000 degrees Fahr., depending on type and use. Available in various grades to meet specific thermostatic requirements.

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**U-LOY**—Republic Steel Corp., Cleveland. Copper-bearing steel with good corrosion resistance, available in hot rolled and galvanized sheets.

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**ULTRA-CUT**—Bliss & Laughlin Inc., Buffalo, N. Y. High sulphur bessemer screw stock furnished in cold finished bars, for miscellaneous automatic screw machine parts.

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**UNION** — Union Drawn Steel Div., Republic Steel Corp., Massillon, O.

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Freecut; carbon .08-.13 max., manganese .6-.9, phosphorus .09-.13, sulphur .16-.23; a free-cutting bessemer type steel.

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Supercut; bessemer type; carbon .08-.13 max., manganese .6-.9, phosphorus .09-.13, and sulphur .23-.32; similar to Freecut.

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Multicut; a free-machining open hearth steel with tensile strength approximately same as S.A.E. 1015.

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Hymo; carbon .13-.18, manganese 1-1.3, phosphorus .045 max., and sulphur .13-.2; recommended for spark plug shells, brake hose couplings, piston pins, king pins and carburized gears.

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Special Carburizing; carbon .13-.18, manganese .6-.9, phosphorus .04 max., sulphur .05 max., silicon .15-.30; recommended for piston pins and carburized gears.

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**U. S. S.**—United States Steel Corp., subsidiaries, including Carnegie-Illinois Steel Corp., Columbia Steel Co., National Tube Co., Tennessee Coal, Iron & Railroad Co., and American Steel & Wire Co.

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Type 302, U. S. S. 18-8; carbon .08-.2, chromium 17-20, nickel 7-10; resists heat to 1650 degrees Fahr., high abrasion resistance; atmospheric and acid resistant; tensile strength ult., 80,000-95,000 lbs. per sq. in. annealed, 105,000-300,000 lbs. per sq. in. cold worked; high ductility; weldability, good; brinell hardness, annealed, 135-185; for food processing and chemical equipment, etc., fabricated by other than welding.

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Type 303, U. S. S. 18-8 F. M.; carbon .2, manganese 1.50, sulphur or selenium .07 min., molybdenum .6, silicon .75, chromium 17.5-20, nickel 8-10; resists heat to 1600 degrees Fahr.; high abrasion resistance; tensile strength, ult., 80,000-95,000 lbs. per sq. in.; high ductility; brinell hardness, untreated, 135-220; for nuts, bolts, valve parts, and shafting.

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Type 304, U. S. S. 18-8-S; carbon .08 max., chromium 18-20, and nickel 8-10; similar to Type 302; abrasion resistant; high ductility; used where corrosion resistance is desired after fabrication by welding.

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Type 309, U. S. S. 25-12; carbon .2, manganese 2, phosphorus .03, silicon .75, chromium 22-26, nickel 12-14. Corrosion and heat resistant; high abrasion resistance; tensile strength, ult., 90,000-110,000 lbs. per sq. in.; high ductility; brinell hardness, untreated, 150-185; for high temperature service, 2100 degrees Fahr. max.

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Type 316, U. S. S. 18-8 Mo.; carbon .1, manganese 2, phosphorus .03, silicon .75, chromium 16-18, nickel 10-14 max., molybdenum 2 to 3. Corrosion and heat resistant; high abrasion resistance, tensile strength, ult., 80,000-95,000 lbs. per sq. in.; high ductility for chemical and food equipment.

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Type 321, U. S. S. 18-8-Ti.; carbon .1 max., chromium 17-20, nickel 7-10, silicon .75, manganese 2, phosphorus .03, titanium four times actual carbon minimum; addition of titanium prevents susceptibility to intergranular corrosion. Tensile strength, 80,000-95,000 lbs. per sq. in.; high ductility; abrasion resistant; high temperature service and where welded parts are subject to corrosion.

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Type 347, U. S. S. 18-8 Cb.; carbon .1, chromium 17-20, nickel 8-12, manganese 2, phosphorus .03, silicon .75, columbium 10 times carbon min.; addition of columbium prevents susceptibility to intergranular corrosion; tensile strength, ult., 80,000-95,000 lbs. per sq. in.; high abrasion resistance; for high temperature service and where welded parts are subject to corrosion.

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Type 410, U. S. S. 12; carbon .15, manganese .75, phosphorus .03, sulphur .03, silicon .75 max., chromium 10-14, corrosion and oxidation resistant; responds to heat treatment and can be modified by addition of columbium, aluminum and molybdenum for specific application; tensile strength, ult., 65,000-85,000 lbs. per sq. in. annealed, 100,000-200,000 lbs. per sq. in. heat treated; high ductility; high abrasion resistance; for turbine blading, shafting, valve parts, wire cable, screens, nuts and bolts.

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Type 416, U.S.S.-12 F.M.; carbon .15, manganese 1.25, phosphorus .04, sulphur or selenium .07 or molybdenum .6, silicon .75 max., chromium 12-14; similar to Type 410 except addition of sulphur, selenium or molybdenum increases the machinability; not to be used where welding is required; used for shafting, nuts, bolts, valve, trim and valve parts.

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Type 430, U.S.S.-17; carbon .12 max., manganese .75, phosphorus .03, sulphur .03, silicon .75, chromium 14-18, nickel .5; resists corrosion caused by nitric acid, atmosphere and industrial corrosives; resists heat to 1550 degrees Fahr.; medium abrasion resistance; tensile strength, ult., 70,000-90,000 pounds per square inch; used in nitric acid equipment, as screens, valves, shafting, nuts, bolts, rivets and plate construction.

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Type 446, U.S.S.-27; carbon .35, manganese 1, phosphorus .035, sulphur .035, silicon 1.5, chromium 23-30, nickel 1; resists heat to

*(Continued on Page 50-D)*

# Index of Alloys by Principal Constituents

SPECIFICATION of a material for a machine part may be made by the designer or engineer by listing the required alloying elements and their proportions. Such a specification affords no ready key to tradenames of alloys with the desired composition. To provide such a key between tradenames and alloying constituents, the following tables have been developed.

The table is divided into three sections, "Iron and Steel Alloys," "Copper Base Alloys," and "Other Alloys." Each of these sections is headed by a list of ten elements numbered from 1 through 0. The tradenames of alloys listed in each section are also listed alphabetically in the "Metals" section of the Directory of Materials where their physical properties, quantitative composition and outstanding characteristics are also given.

The index number at the left of each tradename in the following is a key to the more important elements in the composition of the alloy. The digits comprising each index number each refer to one of the elements listed in bold face type at the head of the sections.

For example, if the tradenames are desired under which a low carbon, nickel, molybdenum alloy steel may be obtained, the following steps should be followed:

1. Select from the list of ten elements in the section on iron and steel alloys the numbers corresponding to the alloying constituents. Hence, low carbon is 1, nickel, 8 and molybdenum, 7.
2. Arrange these three numbers in ascending numerical order; thus, 178.
3. Run down the list of tradenames to 178. Three will be found, Amercut, Armco and Carpenter, each of which is a low carbon nickel, molybdenum steel.
4. Further information on each of these may be obtained by referring to the alphabetical listing of the tradenames under "Metals."

It is recognized that there are more than ten alloying elements in each group, but in the interests of simplicity the number of elements used in the key has been restricted to ten. The large majority of the alloys has been identified by four elements or less. A given alloy may have several more constituent elements than this, but the intent of the table is to identify each alloy by only its more important or controlling elements.

Carbon content of cast irons being relatively unimportant, the carbon classification numbers (1 and 2) are omitted. Hence the copper-nickel casting alloys Waukesha and Tophet bear number 58 rather than 258. This also serves the purpose of distinguishing cast iron alloys from steels.

## IRON & STEEL ALLOYS

**1 CARBON (low-medium)**
**2 CARBON (medium-high)**
**3 CHROMIUM**
**4 COBALT**
**5 COPPER**
**6 MANGANESE**
**7 MOLYBDENUM**
**8 NICKEL**
**9 SILICON**
**0 VANADIUM**

1 Amercut
1 Frankite
1 J. & L. Correct Bal.
1 Jalcase
2 Elastuf Penn
2 Enduro
2 Pompton
2 Red Anchor
3 Lo Cro
3 Ohmaloy
3 Sivyer
3 Temp Alloy
5 Beth-Cu-Loy
5 Inland
6 Abrasoweld
6 Amsco
6 Cast Alloy Steel
6 Rol-Man
6 Sivyer
6 Strainfree Elastuf
6 Tisco
6 Toledo Alloy
8 Allegheny Ludlum
8 Driver Harris
8 Hipernik
8 Hytemco
8 Lukens
8 Nilvar
8 Nipermag
9 Allegheny Ludlum
9 Armco
9 Ermal
13 Bethadur
13 Defiheat
13 Defirust
13 Enduro
13 Rezistal
13 Rustless
13 Superior Stainless
15 AW
15 Electrunite
15 Promal
16 Max-El
16 Naco
16 Neloy
16 Union
17 Economo
17 Lukens
18 Carpenter
20 Python
23 Carpenter Presto
23 EIS
23 Kleenkut
23 Teton
26 Rol-Man
30 Carpenter
34 Wilrich
35 Cupaloy
35 Lukens
36 Carbomang
36 Hascrome
36 Lukens
37 Almo
37 Amsco
37 Carpenter
37 Cast Alloy Steel
37 Duquesne Special
37 Lo Cro
37 Nitralloy
37 Sandusky Alloy Iron
37 Sivyer
37 Timken
37 Tisco
37 U. S. S.
38 Amsco
38 Cast Alloy Steel
38 Chromax
38 Chromel
38 Cimet
38 Colmonoy
38 Cromin D
38 Duplex
38 Dynamic Steel
38 Economet
38 Frankite
38 Hubbard Special
38 Mayari
38 NA, NA-1, NA-2
38 Nichrome
38 Ni-Hard
38 Q-Alloys
38 Simplex
38 Sivyer
38 Standard Alloy
38 Wilrich
38 X-7
38 X-ite
45 Cuferco
48 Alnico
48 Konal
48 Kovar
57 Birdsboro
57 Electrunite
57 Toncan Iron
58 Tophet
58 Waukesha
60 Dynamic Steel
60 Lukens
67 Cast Alloy Steel
67 Dynamic Steel
67 Lukens
67 Timken
68 Allegheny Ludlum
68 Cast Alloy Steel
68 Dynamic Steel
68 Sivyer
68 Timang
69 Carpenter
69 Inland
69 Meehanite
69 Z-Metal
70 Cumloy

367 Hy-Ten
367 U.S.S.
368 Stoodite
369 U.S.S.
378 Elastuf 44
378 Hastelloy
378 Hy-Ten
380 Mayari
578 Republic
678 Dynamic Steel
678 Manganweld
730 Dynamic Steel
1358 Mayari
1360 Hylastic
1367 Dragon
1368 Allegheny Ludlum
1368 Rita
1369 Allegheny Ludlum
1370 Heppenstall
1378 Enduro
1378 Hardtem
1378 Heppenstall
1378 Proferall
1379 B. & W. Croloy
1379 Sicromo
1389 Enduro
1569 U.S.S. AR Steel
1679 Silmo
2347 Krokoloy
2347 Martin Steel
2368 Rita
2369 Allegheny Ludlum
2378 EIS
2678 Tioga
2689 Amsco
3567 Flamaloy
3568 Ni-Resist
3569 U.S.S. Man-Ten
3569 U.S.S. Cor-Ten
3569 N-A-X High Tensile
3578 Illium
3578 Durimet
3670 Timken
3678 Farrell's 85
3679 DM Steel
3679 DM 44
3789 Worthite
5689 Ductiloy
5690 Toledo Alloy
6789 Cecolloy Iron

## COPPER BASE ALLOYS

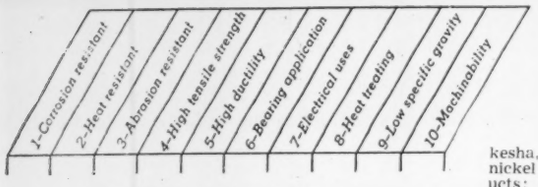
**1 ALUMINUM**
**2 ANTIMONY**
**3 BERYLLIUM**
**4 IRON**
**5 LEAD**
**6 MANGANESE**
**7 NICKEL**
**8 SILICON**
**9 TIN**
**0 ZINC**

0 Bridgeport
0 Copperoid
0 Doler-Brass
0 Mill Brass Mix
0 Scovill
0 Wolverine
1 Avialite
1 Williams No. 50
3 Riverside
3 Trodaloy No. 1
4 Agricola
4 Cuferco
5 Beckett Metal
5 Bunting
7 Advance
7 Anaconda
7 Bridgeport Tubing
7 Bulldog Brand
7 Bunting
7 Chase
7 Chase Tellurium
7 Copel
7 Revere Cupro-Nickel
7 Scovill
7 Waukesha
8 Ti-Copper No. 39
8 Williams No. 51
9 Bridgeport
9 Compo
9 Durex
9 Gramix
9 JSB
9 Lumen Alloys
9 Metaline
9 Mill Brass Mix
9 Moraine
9 Oilite
9 Porex
9 Promet
9 Randall
9 Riverside
9 Selflube
9 Trualoy
10 Bridgeport Tubing
10 Frontier
10 Revalon
10 Wolverine
14 Alcumite
14 Ampco Metal
14 Ampcoloy
14 Frontier
14 Wilrich
17 Tempaloy
18 Auromet
19 Federal-Mogul
19 Lumen Alloys
19 McGill
19 Bulldog Brand
19 Trualoy
29 Mogul Babbitt
37 Anaconda
50 Chase
50 Scovill Free-Cutting
50 Wolverine
59 Anfriloy
59 Commercial
59 Dixoilbronz
59 Federal Mogul Bronze
59 Hy-Speed
59 Johnson
59 Ledaloyl
59 Lubrico
59 Lumen
59 Sabeco
59 Sumet
68 Everdur
69 Lumen Alloys
70 Ambrac
70 Riverside
79 Adnic
79 Lumen Alloys
80 Olympic Bronze
89 Herculoy
89 McGill
89 PMG Metal
90 Admiralty Metal
90 Blackskin Admiralty
90 Bound Brook
90 Brassoid
90 Bridgeport Tubing
90 Chamet Bronze
90 Chase
90 Cramp Alloys
90 Diamond G Bronze
90 Idealoy
90 Johnson
90 Lumen Alloys
90 Machinebronze
90 Magnolia
90 Oreide
90 Roman Bronze
90 Sandusky Bronze
90 Naval Brass
90 Superloy
90 Tobin Bronze
90 Wolverine
147 Tuf-Stuf
290 Antimonial Admiralty
570 Scovill Hardware
579 Johnson
580 Olympic Bronze
590 Anaconda
590 Bunting
590 Chamet Bronze
590 Chase 444 Bronze
590 Johnson
680 Aeterna 600 Metal
690 Sandusky Bronze
790 Nicuite
1460 D-H-S Bronze
1489 Duronze Alloys

## OTHER ALLOYS

**1 ALUMINUM**
**2 WHITE METALS**
**3 CHROMIUM**
**4 COPPER**
**5 MAGNESIUM**
**6 MANGANESE**
**7 NICKEL**
**8 SILICON**
**9 TUNGSTEN**
**0 ZINC**

0 Doler-Zink
0 Metals Disintegrating
1 Alclad
1 Bohnalite
1 Doler-Alumin
1 Lynite
1 Metals Disintegrating
1 Oxweld
1 Trualoy
1 Wolverine
2 Acorn
2 Adamant
2 Bearite
2 Bermax
2 Cerrobase
2 Cerrobend
2 Cerromatrix
2 Cloverleaf Babbitt
2 Dutch Boy Babbitt
2 Glyco Babbitt
2 Grapho
2 Metals Disintegrating
2 Mogul Babbitt
3 Metals Disintegrating
4 Elkaloy
4 Metals Disintegrating
4 MRCO Metal Powder
4 OFHC
4 PDCP
6 Doler-Mag
6 Metals Disintegrating
7 Metals Disintegrating
7 Nickel
8 Metals Disintegrating
9 Borium
9 Carboloy
9 Elkonite
9 Firthaloy
9 Firthite
9 Haystellite
9 Kennametal
9 Metals Disintegrating
9 Talide
13 American
14 Alcoa
15 Mazlo
16 Alcoa
16 Wolverine
17 American
18 Alcoa
18 Aluminweld
18 Precision
18 Wellcast 17 S
24 Johnson
34 Mallory
37 Chromaloid
37 Hastelloy
37 K-42-B
37 Tophet
39 Delloy
39 Haynes Stellite
56 Dowmetal
56 Mazlo
70 Nickeloid
78 Hastelloy
125 Mazlo
135 Alcoa
148 Alcoa
150 Mazlo
150 Precision
156 Alcoa
156 Dowmetal
158 Alcoa
158 Mazlo
240 Easy-Flo
450 Zilloy
1240 T-1 Aluminum
1358 Alcoa
1450 Precision
1450 Zamak
1456 Alcoa
1560 Dowmetal
4678 Inconel
4678 Monel
4678 Nickel
4678 Shenango-Penn
13458 Alcoa
14568 Alcoa




*(Continued from Page 47-D)*

2100 degrees Fahr.; medium abrasion resistance; tensile strength, ult., 75,000-95,000 pounds per square inch; for high temperature service, where resistance to sulphides and concentrated nitric acid is required.

Type 501, U.S.S.-5; carbon over .1 and chromium 4-6.

Type 502, U.S.S.-5-S; carbon .1 max., chromium 4-6; molybdenum .5 is added to increase creep strength and avoid temper brittleness; columbium is added to eliminate air hardening and increase oxidation resistance slightly.

1 2 - - - - - - - -

Shelby 5 per cent chrome molybdenum tubing; used for furnace tubes in oil cracking stills, condensers and superheaters where high temperatures and pressures, and corrosive fluids are handled; chromium .15 max., manganese .5 max., silicon .5 max., carbon 4-6, and molybdenum .45-.65.

Shelby tubing may be obtained in many additional grades from the lowest carbon boiler tube steel to the stainless grades of alloy steel which are available in tubing in all sizes up to 10¾ inches outside diameter. A number of steels made to S.A.E. standards are also furnished in Shelby tubing.

Castings furnished by Lorain Div.; Type A-1: carbon .3-.4, chromium .75-1, nickel 2.5-3, manganese .6-.8, and molybdenum .3-.4; Type A3; carbon .45-.55, chromium .75-.9, nickel .6-.8, manganese 1.5-2, and molybdenum .3-.4; and Type MS-1; carbon 1-14, chromium .75-1, manganese 10-14.

- - - - 5 - 7 - - -

Electrical steel sheets for use in transformers, motors and generators; eleven principal grades of electrical sheets furnished—U.S.S. Pole, Field, Armature, Electrical, Motor, Dynamo, Radio Transformer 72, and Transformer 72, 65, 58, and 52.

1 - - 4 - - - - 8 - -

Other materials are furnished as follows: Carnegie-Illinois Steel Corp., stainless steel in sheets, plates, shapes and bars; National Tube Co., in pipe and tubular shape; and American Steel & Wire Co., in strip and wire forms.

- - 3 4 - 6 - - - -

**U.S.S. AR STEEL (Abrasion Resisting Steel)**—Carnegie-Illinois Steel Corp., Pittsburgh. Carbon .35-.5, manganese 1.5-2, phosphorus .05 max., sulphur .055 max., silicon .15-.3; furnished in bars or billets, sheets, strip, plates and shapes; high abrasion resistance; brinell hardness 200-275 as rolled, heat treated 350-450. Used for wear resisting surfaces.

- - 3 4 - 6 - - - -

**U.S.S. CARILLOY**—Carnegie-Illinois Steel Corp., Pittsburgh. Alloy steels in all standard grades of S.A.E. steels sold under the above tradename.

1 - - 4 5 - - - - -

**U.S.S. COR-TEN**—Carnegie-Illinois Steel Corp. Pittsburgh. Carbon .12 max., manganese .10-.50 max., silicon .35-1.00, copper .3-.5, chromium .5-1.50; furnished in bars or billets, sheets, strip, plates, structural and bar shapes, for hot and cold forming, welding, riveting, turning, etc. Resists atmospheric corrosion four to six times that of plain carbon steel; abrasion resistance, good; yield point 50,000 min.; tensile strength 70,000 min. lbs. per sq. in., with exceptionally high ductility; bearing properties, good; weldability, good. Used for lightweight construction.

- - 3 4 5 - - - - -

**U.S.S. MAN-TEN**—Carnegie-Illinois Steel Corp., Pittsburgh. Carbon .3 max., manganese 1.10-1.60, phosphorus .04 max., silicon .3 max., sulphur .05 max., copper .2 min.; furnished in bars or billets, sheets, strip, plates, structural and bar shapes, for hot and cold forming, welding and riveting; corrosion resistant; high abrasion resistance; yield point 50,000 min.; tensile strength 75,000 min. lbs. per sq. in.; good ductility and weldability. Used for frames and light machine parts.

- - - 4 5 - - - - -

**UNIVAN**—Union Steel Casting Co., Pittsburgh. Nickel vanadium alloy; tensile strength 90,000 lbs. per sq. in.; for locomotive frames, crossheads, coupling boxes, driving wheel centers, etc.

## W

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**WAUKESHA** — Waukesha Foundry Co., Waukesha, Wis. Copper base alloy with high nickel content; resists acids in food products; recommended for sand cast parts for food handling and dairy machinery. White in color, is easy to machine and also polishes well.

- - 3 4 - - - - - -

**WEARTUF**—Horace T. Potts Co., Philadelphia. Carbon-manganese-silicon abrasion resisting alloy steel, furnished in sheets and plates, for hot forging, welding, forming, turning, boring, etc. Abrasion resistance, medium; ductility, low; good weldability; brinell hardness, untreated 265. Used for wear and abrasion resistant applications such as hoppers, chutes, conveyors and other similar types of parts.

- - 3 - - - - - - -

**WEARWELD**—Lincoln Electric Co., Cleveland; brinell hardness 488-548; suitable for hardfacing wearing surfaces subject to shocks and abrasion.

- - - 4 5 - - - - -

**WELLCAST 17 S** — The Wellman Bronze & Aluminum Co., Cleveland. High-strength, aluminum-silicon-titanium alloy with high ductility; used in aircraft castings; tensile strength, 28,000-30,000 lbs. per sq. in.

- - - - - - 7 - - -

**WILCO CONTACT MATERIALS, Electrical**—The H. A. Wilson Co., Newark, N. J. Silver, platinum, tungsten and alloy contacts; silver-steel laminated contacts for projection welding; silver composite contacts; silver and platinum inlay and overlay on base metals. Furnished in sheet and wire.

***See advertisement, Page 85-D***

- - - - - - 7 - - -

**WILCO THERMOMETAL**—The H. A. Wilson Co., Newark, N. J. Thermostatic bimetals furnished in strips and formed parts for temperature control and temperature compensation.

***See advertisement, Page 85-D***

1 - - 4 - 6 - - - -

**WILLIAMS No. 50 ALUMINUM BRONZE**—E. A. Williams & Son, Jersey City, N. J. Furnished as sand castings; resists corrosion caused by almost all acids except nitric, hydrofluoric, sulphurous; abrasion resistance, high; tensile strength, ult., 75,000-85,000 lbs. per sq. in.; yield point 33,000-41,000 lbs. per sq. in.; medium ductility; bearing properties, good; brinell hardness, 167-175; for use as bushings, gears, worm wheels, acid equipment dies.

1 - 3 4 - - - - - -

**WILLIAMS No. 51 SILICON BRONZE**—E. A. Williams & Son, Jersey City, N. J. Furnished as sand castings; resists corrosion caused by all commercial acids, and sea water; high abrasion resistance; tensile strength 45,000-58,000 lbs. per sq. in.; high ductility; specific gravity 8.44; good bearing and welding properties; brinell hardness, untreated 90-100. Used for parts where strength, corrosion resistance and soundness are required.

1 2 - - - - - - - -

**WILRICH**—Wilcox-Rich Div., Eaton Mfg. Co., Detroit.

Type 301; high-nickel, high-chrome boron alloy; machinable, heat and corrosion resistant. Available in centrifugal cast cylinders or steel-backed, fused bimetal cylinders.

Type 625; chrome-cobalt-boron alloy; heat and corrosion resistant. Available in centrifugal cast cylinders or steel-backed, fused bimetal cylinders.

Aluminum bronze; machinable and corrosion resistant. Available in centrifugal cast cylinders or steel-backed, fused bimetal cylinders.

1 - - - - 6 - - - -

**WOLVERINE**—Wolverine Tube Co., Detroit.

Aluminum brass; copper 76, zinc 22, aluminum 2; furnished in tubing; corrosion resistant; medium abrasion resistant; tensile strength 52,000-100,000 lbs. per sq. in.; for bushings, condenser tubing.

Admiralty brass; copper 70, zinc 29, tin 1; furnished in tubing; medium abrasion resistance; tensile strength 48,000-90,000 lbs. per sq. in.; for condenser tubing.

- - - - - - - - - -

70-30 brass; copper 70, zinc 30; furnished in tubing; corrosion resistant; medium abrasion resistant; tensile strength 48,000-88,000 lbs. per sq. in.; used for condenser tubing.

1 - - - - 5 - - - - -

Red brass; copper 85, zinc 15; furnished in tubing; corrosion resistant; medium abrasion resistance; tensile strength 40,000-69,000 lbs. per sq. in.; high ductility; for condenser tubing.

1 - - - - - 6 - - - -

Common high brass; copper 66, lead .65 max., zinc balance; furnished in tubing; corrosion resistance; medium abrasion resistance; tensile strength 48,000-85,000 lbs. per sq. in.; for cupped, formed or drawn parts, etc.

1 - - - - 5 - - - - -

Copper, oxygen-free; copper and silver 99.9 min., phosphorus .015-.035 (optional as deoxidizer); furnished in tubing; corrosion resistant; tensile strength 31,000-60,000 lbs. per sq. in.; high ductility; for condensers, evaporators, heaters and condenser tubes, sugar mills, refrigeration, etc.

Copper, arsenical; copper and silver 99.2 min.; phosphorus .015-.035, arsenic .15-.50; balance is the same as oxygen-free copper.

Commercial bronze; copper 90, zinc 10; furnished in tubing; corrosion resistant; available in color; medium abrasive resistance; tensile strength 36,000-63,000 lbs. per sq. in.; high ductility; for ornamental purposes.

Low brass; copper 80, zinc 20; furnished in tubing; resists corrosion; medium abrasive resistance; high ductility; tensile strength 43,000-78,000 lbs. per sq. in.; for bellows, ornamental purposes and various fabricated parts.

1 - - - - - 6 - - - -

Phosphorized arsenical Admiralty brass; copper 70, zinc 29, tin 1, phosphorus .015 max., arsenic .35 max.; furnished in tubing; corrosion resistant; balance same as Admiralty brass.

- - - - - - 6 - - - 10

High brass (2 & 1); free turning; copper 66, lead 1.75, zinc balance; furnished in tubing; corrosion resistant; medium abrasion resistance; tensile strength 48,000-85,000 lbs. per sq. in.; machinability; for screw machine parts and fabricated parts.

1 - - - - - - - - - -

Naval brass; copper 60, tin .75, zinc balance; furnished in tubing; corrosion and abrasion resistance; tensile strength 55,000-100,000 lbs. per sq. in.; used where corrosion resistance with high strength is required.

1 - - - - - - - - - -

Muntz metal; copper 60, zinc 40, furnished in tubing; corrosion and abrasion resistance; tensile strength 48,000-85,000 lbs. per sq. in.; for condenser tubes, etc.

1 - - - - - - - - - -

Aluminum 2S; aluminum 99; furnished in tubing; ductility good; tensile strength 13,000-24,000 lbs. per sq. in.; machinability poor; used for airplane parts, oil burners, etc., where light weight is important.

Aluminum 3S; aluminum 97, manganese 1.25; furnished in tubing; ductility good; tensile strength 16,000-29,000 lbs. per sq. in.; machinability good; used for airplane parts, oil burners, etc., where light weight is desired.

1 - 3 - - - - - - -

**WORTHITE**—Worthington Pump & Machinery Corp., Harrison, N. J. Nickel 24, chromium 20, molybdenum 3, silicon 3.5, carbon .07 max., other elements 2, balance iron; furnished in finished rods or bars and as sand and centrifugal castings for turning, boring, welding, etc.; corrosion resistant; heat resistance 2000-2200 degrees Fahr.; high abrasion resistance; tensile strength 97,000 lbs. per sq. in. hot rolled, 72,000 lbs. per sq. in. sand cast; medium ductility. Used for pumping equipment, valves, pipe fittings and special apparatus for corrosion resistance.

## X, Y

- 2 - 4 - - - - - -

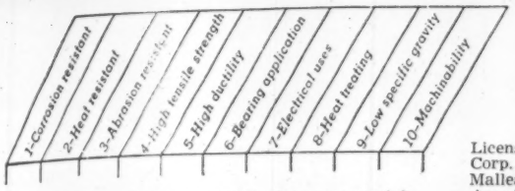
**X-7**—General Alloys Co., Boston. Chrome 23-28, nickel 10-13; tensile strength 80,000 lbs. per sq. in.; recommended for castings subject to temperatures to 2000 degrees Fahr.

- - 3 - - 6 - - - -

**XALOY** — Wilcox-Rich Div., Eaton Mfg. Co., Detroit. Carbon 3.25, boron 1, silicon .75, nickel 4; available as centrifugal castings, blanks or finished parts; resists heat up to 800 degrees Fahr.; high abrasion resistance; tensile strength 30,000 to 45,000 lbs. per sq. in.; compressive strength 225,000; ductility low, specific gravity 7.58; good bearing properties; high magnetic properties; brinell hardness, as cast, 700 to 750. Used for rolls, dies, sleeves, seals, bushings, collets, etc.

- 2 - - - - - - - -

**X-ITE**—General Alloys Co., Boston. Nickel 37-40, chromium 17-21; for furnace castings not subjected to alternate heating and cooling




cycles; standard material for commercial heat treating furnace parts.

1 - - 4 5 - - - - - -

**YOLOY**—Youngstown Sheet & Tube Co., Youngstown, O. Special service alloy steel of increased tensile strength and high ductility combined with corrosion resistance, machinability and weldability.

## Z

- - - 4 - - - - - 10

**Z-METAL**—Ferrous Metals Corp., New York. Carbon 2-2.5, silicon 1, manganese .75-1, sulphur .08, phosphor .15; furnished as sand castings; resists heat up to 1000 degrees Fahr.; high abrasion resistance; tensile strength 75,000-90,000 lbs. per sq. in.; compressive strength 125,000; medium ductility; good bearing properties; high yield point; for use as cams, cranks, gears, rocker arms.

Licensees: Chain Belt Co., Gunite Foundries Corp., Acme Stamping & Mfg. Co., Eastern Malleable Iron Co., Erie Malleable Iron Co., Arcade Malleable Iron Co., and Chicago Railway Equipment Co.

1 - - 4 5 - - - - - -

**ZAMAK**—New Jersey Zinc Co., New York. Zinc alloys for die cast parts.

No. 2; aluminum 4.1, copper 2.7, magnesium .03, remainder Horse Head Special zinc.

No. 3; aluminum 4.1, magnesium .04, remainder Horse Head Special zinc.

No. 5; aluminum 4.1, copper 1, magnesium .03, remainder Horse Head Special zinc.

1 - - 4 5 - - - - - -

**ZILLOY**—New Jersey Zinc Co., New York. Copper .85-1.25, magnesium .006-.016, balance zinc; furnished in sheets and strips for stamping; resists corrosion caused by moisture; resists heat to 250 degrees Fahr.; medium abrasion resistance; tensile strength, 20,000-45,000 lbs. per sq. in.; compressive strength, 40,000-80,000; medium ductility; used for nameplates, small cover plates and caps, escutcheons, and molding trim.

1 - - - - 5 - - - - - -

**ZINCGRIP** — American Rolling Mill Co., Middletown, O. Galvanized sheet iron or steel, in strips or coils, with unusual forming and drawing qualities; for use wherever severe forming makes ordinary galvanized sheet metal unsatisfactory.

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Hot and cold rolled steels; obtainable in ARMCO ingot iron and ARMCO high tensile steel, copper-bearing steel and varying analyses of medium and low carbon steel. Available in sheet form; for severe forming requirements.

1 - - - - 5 - - - - - -

Long ternes; terne coated sheets with ingot iron, mild steel, or high tensile steel base metal. For deep drawing requirements and paintability.

Spiral-welded pipe, in wall thicknesses of 7/64 to ½ inch, diameters 6 to 36 inches and lengths up to 50 feet; supplied mill coated, galvanized or bituminous coated and lined. Available standard or custom-built fittings. Base metal mild or high tensile steel.

# New SAE Steel Classifications

| | SAE No. | AISI‡ Type | Carbon | Manganese | Phosphorus | Sulfur | Chromium | Nickel | Molybdenum | Vanadium | Silicon | Selenium | Titanium or Columbium |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Carbon Steels** | 1010 | ... | .05-.15 | .30-.60 | .045 Max. | .055 Max. | | | | | | | |
| | 1015 | ... | .10-.20 | .30-.60 | .045 Max. | .055 Max. | | | | | | | |
| | X1015 | ... | .10-.20 | .70-1.00 | .045 Max. | .055 Max. | | | | | | | |
| | 1020 | ... | .15-.25 | .30-.60 | .045 Max. | .055 Max. | | | | | | | |
| | X1020 | ... | .15-.25 | .70-1.00 | .045 Max. | .055 Max. | | | | | | | |
| | 1025 | ... | .20-.30 | .30-.60 | .045 Max. | .055 Max. | | | | | | | |
| | X1025* | ... | .20-.30 | .70-1.00 | .045 Max. | .055 Max. | | | | | | | |
| | 1030 | ... | .25-.35 | .60-.90 | .045 Max. | .055 Max. | | | | | | | |
| | 1035 | ... | .30-.40 | .60-.90 | .045 Max. | .055 Max. | | | | | | | |
| | 1040 | ... | .35-.45 | .60-.90 | .045 Max. | .055 Max. | | | | | | | |
| | 1045 | ... | .40-.50 | .60-.90 | .045 Max. | .055 Max. | | | | | | | |
| | 1050 | ... | .45-.55 | .60-.90 | .045 Max. | .055 Max. | | | | | | | |
| | 1055 | ... | .50-.60 | .60-.90 | .040 Max. | .055 Max. | | | | | | | |
| | 1060 | ... | .55-.70 | .60-.90 | .040 Max. | .055 Max. | | | | | | | |
| | 1065* | ... | .60-.75 | .60-.90 | .040 Max. | .055 Max. | | | | | | | |
| | X1065* | ... | .60-.75 | .90-1.20 | .040 Max. | .055 Max. | | | | | | | |
| | 1070 | ... | .65-.80 | .60-.90 | .040 Max. | .055 Max. | | | | | | | |
| | 1075 | ... | .70-.85 | .60-.90 | .040 Max. | .055 Max. | | | | | | | |
| | 1080 | ... | .75-.90 | .60-.90 | .040 Max. | .055 Max. | | | | | | | |
| | 1085 | ... | .80-.95 | .60-.90 | .040 Max. | .055 Max. | | | | | | | |
| | 1090 | ... | .85-1.00 | .60-.90 | .040 Max. | .055 Max. | | | | | | | |
| | 1095 | ... | .90-1.05 | .25-.50 | .040 Max. | .055 Max. | | | | | | | |
| **Free Cutting Steels** | 1112 | ... | .08-.16 | .60-.90 | .09-.13 | .10-.20 | | | | | | | |
| | X1112 | ... | .08-.16 | .60-.90 | .09-.13 | .20-.30 | | | | | | | |
| | 1115 | ... | .10-.20 | .70-1.00 | .045 Max. | .10-.20 | | | | | | | |
| | X1314 | ... | .10-.20 | 1.00-1.30 | .045 Max. | .10-.20 | | | | | | | |
| | X1315 | ... | .10-.20 | 1.30-1.60 | .045 Max. | .10-.20 | | | | | | | |
| | X1330 | ... | .25-.35 | 1.35-1.65 | .045 Max. | .10-.20 | | | | | | | |
| | X1335 | ... | .30-.40 | 1.35-1.65 | .045 Max. | .10-.20 | | | | | | | |
| | X1340 | ... | .35-.45 | 1.35-1.65 | .045 Max. | .10-.20 | | | | | | | |
| **Manganese Steels** | 1330 | ... | .25-.35 | 1.60-1.90 | .040 Max. | .050 Max. | | | | | | | |
| | 1335 | ... | .30-.40 | 1.60-1.90 | .040 Max. | .050 Max. | | | | | | | |
| | 1340 | ... | .35-.45 | 1.60-1.90 | .040 Max. | .050 Max. | | | | | | | |
| | 1350* | ... | .45-.55 | 1.60-1.90 | .040 Max. | .050 Max. | | | | | | | |
| **Nickel Steels** | 2315 | ... | .10-.20 | .30-.60 | .040 Max. | .050 Max. | | 3.25-3.75 | | | | | |
| | 2330 | ... | .25-.35 | .50-.80 | .040 Max. | .050 Max. | | 3.25-3.75 | | | | | |
| | 2340 | ... | .35-.45 | .60-.90 | .040 Max. | .050 Max. | | 3.25-3.75 | | | | | |
| | 2345 | ... | .40-.50 | .60-.90 | .040 Max. | .050 Max. | | 3.25-3.75 | | | | | |
| | 2515* | ... | .10-.20 | .30-.60 | .040 Max. | .050 Max. | | 4.75-5.25 | | | | | |
| **Nickel Chromium Steels** | 3115* | ... | .10-.20 | .30-.60 | .040 Max. | .050 Max. | .45-.75 | 1.00-1.50 | | | | | |
| | 3120 | ... | .15-.25 | .50-.80 | .040 Max. | .050 Max. | .45-.75 | 1.00-1.50 | | | | | |
| | 3130* | ... | .25-.35 | .50-.80 | .040 Max. | .050 Max. | .45-.75 | 1.00-1.50 | | | | | |
| | 3135 | ... | .30-.40 | .50-.80 | .040 Max. | .050 Max. | .45-.75 | 1.00-1.50 | | | | | |
| | 3140 | ... | .35-.45 | .60-.90 | .040 Max. | .050 Max. | .45-.75 | 1.00-1.50 | | | | | |
| | X3140 | ... | .35-.45 | .60-.90 | .040 Max. | .050 Max. | .60-.90 | 1.00-1.50 | | | | | |
| | 3145 | ... | .40-.50 | .60-.90 | .040 Max. | .050 Max. | .45-.75 | 1.00-1.50 | | | | | |
| | 3150 | ... | .45-.55 | .60-.90 | .040 Max. | .050 Max. | .45-.75 | 1.00-1.50 | | | | | |
| | 3215* | ... | .10-.20 | .30-.60 | .040 Max. | .050 Max. | .90-1.25 | 1.50-2.00 | | | | | |
| | 3220* | ... | .15-.25 | .30-.60 | .040 Max. | .050 Max. | .90-1.25 | 1.50-2.00 | | | | | |
| | 3240* | ... | .35-.45 | .30-.60 | .040 Max. | .050 Max. | .90-1.25 | 1.50-2.00 | | | | | |
| | 3245* | ... | .40-.50 | .30-.60 | .040 Max. | .050 Max. | .90-1.25 | 1.50-2.00 | | | | | |
| | 3250* | ... | .45-.55 | .30-.60 | .040 Max. | .050 Max. | .90-1.25 | 1.50-2.00 | | | | | |
| | 3312 | ... | .17 Max. | .30-.60 | .040 Max. | .050 Max. | 1.25-1.75 | 3.25-3.75 | | | | | |
| | 3415* | ... | .10-.20 | .30-.60 | .040 Max. | .050 Max. | .60-.95 | 2.75-3.25 | | | | | |
| **Molybdenum Steels** | X4130 | ... | .25-.35 | .40-.60 | .040 Max. | .050 Max. | .80-1.10 | | .15-.25 | | | | |
| | 4140 | ... | .35-.45 | .60-.90 | .040 Max. | .050 Max. | .80-1.10 | | .15-.25 | | | | |
| | 4150 | ... | .45-.55 | .60-.90 | .040 Max. | .050 Max. | .80-1.10 | | .15-.25 | | | | |
| | 4320 | ... | .15-.25 | .40-.70 | .040 Max. | .050 Max. | .30-.60 | 1.65-2.00 | .20-.30 | | | | |
| | X4340 | ... | .35-.45 | .60-.90 | .040 Max. | .050 Max. | .60-.90 | 1.65-2.00 | .20-.30 | | | | |
| | 4615 | ... | .10-.20 | .40-.70 | .040 Max. | .050 Max. | | 1.65-2.00 | .20-.30 | | | | |
| | 4620 | ... | .15-.25 | .40-.70 | .040 Max. | .050 Max. | | 1.65-2.00 | .20-.30 | | | | |
| | 4640 | ... | .35-.45 | .50-.80 | .040 Max. | .050 Max. | | 1.65-2.00 | .20-.30 | | | | |
| | 4815 | ... | .10-.20 | .40-.60 | .040 Max. | .050 Max. | | 3.25-3.75 | .20-.30 | | | | |
| | 4820 | ... | .15-.25 | .40-.60 | .040 Max. | .050 Max. | | 3.25-3.75 | .20-.30 | | | | |
| **Chromium Steels** | 5120 | ... | .15-.25 | .60-.90 | .040 Max. | .050 Max. | .60-.90 | | | | | | |
| | 5140 | ... | .35-.45 | .60-.90 | .040 Max. | .050 Max. | .80-1.10 | | | | | | |
| | 5150 | ... | .45-.55 | .60-.90 | .040 Max. | .050 Max. | .80-1.10 | | | | | | |
| | 52100 | ... | .95-1.10 | .20-.50 | .030 Max. | .035 Max. | 1.20-1.50 | | | | | | |
| **Chromium Vanadium Steels** | 6135* | ... | .30-.40 | .60-.90 | .040 Max. | .050 Max. | .80-1.10 | | | .15-.18 | | | |
| | 6150 | ... | .45-.55 | .60-.90 | .040 Max. | .050 Max. | .80-1.10 | | | .15-.18 | | | |
| **Silicon Manganese Steels** | 9250 | ... | .45-.55 | .60-.90 | .040 Max. | .050 Max. | | | | | 1.80-2.20 | | |
| | 9260 | ... | .55-.65 | .60-.90 | .040 Max. | .050 Max. | | | | | 1.80-2.20 | | |
| **Chromium Nickel Austenitic Steels†** | 30615 | 303 | .15 Max. | 2.00 Max. | .040 Max. | .18-.35 | 17.00-20.00 | 7.00-10.00 | .60 Max. | | .75 Max. | | |
| | 30615 | 303 | .15 Max. | 2.00 Max. | .12-.17 | .04 Max. | 17.00-20.00 | 7.00-10.00 | .60 Max. | | .75 Max. | .15-.35 | |
| | 30705 | 321 or 347 | .08 Max. | 2.50 Max. | .03 Max. | .03 Max. | 17.00 Min. | 8.00 Min. | | | 1.50 Max. | | Ti-.40 Min. or Cb-.70 Min. |
| | 30805 | 316 | .10 Max. | 2.50 Max. | .03 Max. | .03 Max. | 16.00-18.00 | 10.00-14.00 | 2.00-3.00 | | .75 Max. | | |
| | 30905 | 304 | .08 Max. | 2.00 Max. | .03 Max. | .03 Max. | 18.00-20.00 | 8.00-10.00 | | | .75 Max. | | |
| | 30915 | 302 | .08-.15 | 2.00 Max. | .03 Max. | .03 Max. | 17.00-20.00 | 7.00-10.00 | | | .75 Max. | | |
| **Stainless Chromium Irons** | 51210 | 410 | .08-.15 | .60 Max. | .03 Max. | .03 Max. | 11.5 -13.0 | | | | .50 | | |
| | 51310 | 414 | .08-.15 | .60 Max. | .03 Max. | .03 Max. | 11.5 -13.5 | 1.25-2.00 | | | .50 | | |
| | 51335 | 420 | .25-.40 | .60 Max. | .03 Max. | .03 Max. | 12.0 -14.0 | | | | .50 | | |
| | X51410 | 416 | .13 Max. | 1.20 Max. | .04 Max. | .18-.35 | 12.0 -14.0 | | .60 | | .75 | | |
| | 51710 | 430 | .12 Max. | .60 Max. | .03 Max. | .03 Max. | 16.0 -18.0 | | | | .50 | | |

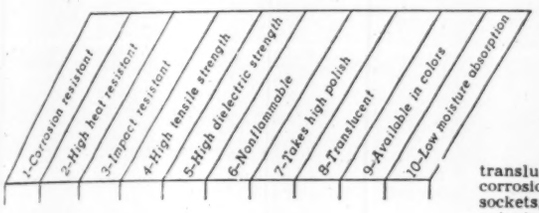
‡American Iron and Steel Institute. *Secondary classification, limited in supply, not extensively used. †Cannot be heat treated.

REDUCTION in the number of SAE steels from 109 to 84—of which 72 are carbon and alloy steels, and 12 corrosion and heat resistant alloys—makes this revised listing of vital interest to engineers. Furthermore, 14 of the 84 steels have been given a new "secondary" classification. Steels in this classification are defined as those not extensively used. Their ultimate elimination, if brought about later because of defense aims, would effect a further reduction to a total of only 70 steels and irons.

The basic code system of SAE numbers remains unchanged. First digit refers to the alloy type; the second, to the approximate percentage of the principal alloying element; and the remaining two or three, to the number of points of carbon.

# Plastics and Other Nonmetallics Listed by Tradenames

*(For listing by producing companies, and complete street addresses, see Page 64-D)*




## A

1 - 3 - - - - - - - - -

**ACADIA**—Western Felt Works, Chicago. Synthetic rubber furnished in sheet form for molding and stamping into parts; abrasion resistant; corrosion resistant; flexible; tensile strength, 1000-4000 lb. per sq. in.; heat resistance, 350-400 degrees Fahr.; low moisture absorption; nonflammable; shatterproof; specific gravity, 1-1.75; used for gasketing, sealing, cushioning in applications where corrosion and aging are encountered.

*See advertisement, Page 89-D*

1 - - - - - - 7 - - 10

**ACE**—American Hard Rubber Co., New York. Hard rubber; thermosetting; furnished in sheets, rods or tubes; may be machined, molded or stamped into part; corrosion resistance; low moisture absorption; high polish; tensile strength 4000-10,000 lbs. per sq. in.; heat resistance 140-190 degrees Fahr.; dielectric strength 450-550 volts per mil.; nonflammable. Uses include handles, caster wheels and special molded parts.

1 2 - - - - 6 - - - -

**AERTITE**—Johns-Manville, New York. Rubbery, asphaltic-asbestos base; furnished in soft plastic form; corrosion resistant, heat resistant; nonflammable. Used on mechanical equipment to prevent air infiltration.

1 - 3 4 - - - - - - -

**AIRVULC**—Self-Vulcanizing Rubber Co. Inc., Chicago. Gum rubber base; furnished in liquid; abrasion and corrosion resistant; tensile strength, 2000 lbs. per sq. in.; shock resistant; high polish; flexible; heat resistance, 212 degrees Fahr.; low moisture absorption; available in colors. Used as a sound deadener and for insulation and waterproofing.

1 - - - - - - - - - 10

**AMBERLITE**—Resinous Products & Chemical Co., Philadelphia. A synthetic resin (adhesive) phenolic resin; furnished in powder form; has low moisture absorption, high density; used in aircraft.

- - - - - 6 7 - 9 -

**AMEROID**—American Plastics Corp., New York. Casein base, thermoplastic; furnished in sheet or rod form, for machining; nonflammable; high polish; available in colors; corrosion resistant; tensile strength, 7600 lbs. per sq. in.; heat resistance, 150 degrees Fahr.; translucent; dielectric strength 290 volts per mil. Used for small knobs, bushings, washers and similar parts.

1 - - - 5 - - - - 10

**AMPHENOL**—American Phenolic Corp., Chicago.

Type 912-B Ribbon; polystyrene base; thermoplastic; furnished in ribbon or thin sheeting from .0005-.015 in. thickness; .001 in. thickness can be highly polished; noncorrosive; flexible; available in colors; nonflammable; translucent; high tensile strength. Used as thin wall for electrical insulation.

Type 912; polystyrene base; thermoplastic; furnished in sheets, rods and tubes for laminating, molding, machining or stamping into parts; high dielectric strength; low moisture absorption; available in colors; translucent; nonflammable; high polish; corrosion resistance. Uses include electrical sockets, plugs, insulators and acid resistant tubing.

1 2 - - - - - - - - 10

**ASBESTOPRENE**—Victor Mfg. & Gasket Co., Chicago. Mineral-base asbestos; furnished in stamped parts; abrasion, corrosion and heat resistant; flexible; high tensile strength; low moisture absorption; nonflammable; shatterproof; used for gaskets in automotive and aviation engines, etc.

## B

1 2 3 - 5 6 - 8 9 10

**BAKELITE**—Bakelite Corp., New York.

1 - - - - 6 - - - 10

Phenolic plastics, general purpose; thermosetting; furnished in powder and blanks for plastic molding; corrosion resistant; dielectric strength 300-500 volts per mil.; nonflammable; tensile strength 6000-11,000 lbs. per sq. in.; low thermal conductivity; available in colors; takes high polish; low lower moisture absorption; nonflammable.

1 2 - - - - - - - - 10

Phenolic plastics, mineral filled. Similar to above but has high heat resistance, low moisture absorption; and is nonflammable.

1 - 3 - 5 - - - - - -

Phenolic plastics, fabric filled. Similar to general purpose phenolic plastics but are much higher in impact resistance; abrasion resistance; dielectric strength 300-400 volts per mil. Used for gears, bushings, bearings and heavy duty parts.

1 - - - 5 - - 8 - -

Urea plastics. Thermosetting; furnished in powder form for plastic molding; specific gravity 1.47-1.52; tensile strength 9500-12,000 lbs. per sq. in.; dielectric strength 330-375 volts per mil.; nonflammable; takes high polish; available in colors. Used for housings and other parts requiring translucent or opaque colors resistant to fading.

- - 3 - - - - 8 9 10

Acetate plastics. Thermoplastic; furnished in powder form for plastic molding; in transparent, translucent and opaque effects, in all colors; takes high polish; impact strength .4-1.8 ft. lbs.; tensile strength 2500-9500 lbs. per sq. in.; suitable for wide variety of mechanical parts requiring brilliant color and high shock resistance.

1 - - - 5 - - - 9 -

Polystyrene plastics. Thermoplastic; furnished in powder form for molding; transparent, translucent and opaque effects, in all colors; takes high polish; nonflammable; low moisture absorption; specific gravity 1.05-1.07; dielectric strength 500-525 volts per mil.; resistivity $10^{9}$ megohm centimeters; power factor .0002-.0003 from 60 cycles to 50,000 cycles; offers exceptional resistance to acids and alkalis.

1 - - - 5 6 - - - -

Cast resins; available in BT 44, 45, 48, 55 and 58 types; in rods, sheets, tubes and many special types of castings. BT 44, 45 and 55 are opaque, translucent and mottled; corrosion resistant; of high dielectric strength; available in colors; and low moisture absorption; used for radio cabinets, etc. BT 48 and 58 are crystal clear, mottled transparents, and transparent colors of any hue; available as castings including rods, sheets and tubes; highly resistant to acids; used in place of glass and can be readily machined and used for gauges, peep holes, etc.

1 2 3 - - - - - - - -

BT 63,000 resin is available in ivory, in rods and many other shapes; used for applications where dimensional stability is required; impact and heat resistant.

1 - 3 4 - - - - - - -

BT 61-893; available in plates only; transparent water white; very stable; color fast; excellent on dimensional stability; used for photoelastic stress study work.

1 - - - 4 - - - - - 10

BT 41-001; available in transparent amber castings and sheets made to order; resistant to hydrofluoric acid; used where very high dielectric strength and low moisture absorption properties are required.

1 - - - 5 - - 8 - -

**BEETLE**—Beetleware Division, American Cyanamid Co., New York. Urea formaldehyde base, thermosetting; furnished in powder and liquid for laminating or molding; available in colors; resistant to shock; translucent; high polish; dielectric strength 385 volts per mil.; tensile strength 5500-7000 lbs. per sq. in. Used for housings, cabinets, knobs, dials, panels and insulators. Material is available with slightly different properties for specific applications.

- 2 - 4 - - - - - 9 -

**BOOTH FELT**—Booth Felt Co. Inc., Brooklyn, N. Y. Wool base felt; furnished in sheets or strips for machining or stamping into parts; heat resistance 400 degrees Fahr.; tensile strength, 5-100 lbs. per sq. in.; available in colors and in a variety of types and grades; used for washers, gaskets, grease seals, and pads for insulating machinery or reducing vibration.

*See advertisement, Page 81-D*

- - 3 - 5 - 7 - - -

**BRANDYWINE FIBRE** — Brandywine Fibre Products Co., Wilmington, Del. Paper chemically treated to form a solid homogeneous mass; furnished in tubes; dielectric strength 250 volts per mil.; tensile strength 5000-8500 lbs. per sq. in.; heat resistance 150-200 degrees Fahr.; available in colors; impact resistant; specific gravity 1.20-1.45. Used for spacers, ferrules, washers, handles, bearings, noiseless bumpers.

## C

- - - 4 - 6 - - - 10

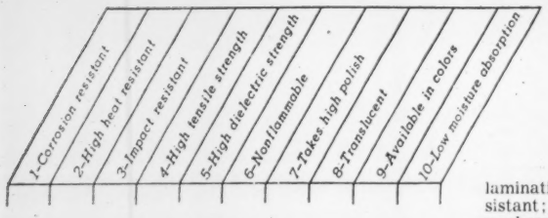
**CATABOND**—Catalin Corp., New York. Phenolic base, thermosetting; furnished in liquid form; excellent abrasion resistance; can be highly polished; dielectric strength, 350-700 volts per mil, ⅛-inch thick; tensile strength, 7000-8000 lb. per sq. in.; heat resistance, 212-300 degrees Fahr.; low moisture absorption; nonflammable; translucent; used for panels, housings, gears, liners, etc.

- - - - - 6 7 8 - -

**CATALIN**—Catalin Corp., New York. Phenolic base, thermosetting; furnished in sheets, rods, or special castings; high dielectric strength; nonflammable; low moisture absorption; high tensile and compressive strengths; available in colors; insoluble in ordinary solvents. Used for clock and instrument cases, auto fittings, knobs for electrical appliances, etc.

1 2 - - - 6 - - - -

**CELITE**—Johns-Manville, New York. Diatomaceous silica material; furnished in powdered, granular and brick forms; resistant to chemical corrosion; heat resistant; nonflammable.




Used for insulation of equipment operating at high temperatures.

- - - 4 - - 7 - 9 -

**CELLULOID**—Celluloid Corp., New York. Cellulose nitrate base, thermoplastic; furnished in sheets, rods and tubes, for molding, swedging, veneering, machining or stamping into parts; available in colors; high polish; tensile strength 5000-10,000 lbs. per sq. in.; flexible; resistant to corrosion; dielectric strength 600-1200 volts per mil; transparent. Used for instrument dials, tool handles, key buttons, register wheels, etc.

1 - 3 - - - - 8 - -

**CEL-O-GLASS**—E. I. du Pont de Nemours & Co., Wilmington, Del. Plastic-coated wire mesh which transmits ultra-violet rays; corrosion resistant; resistant to shock; translucent; flexible; light weight. Used for sign boards, display backgrounds or any place where an opalescent or translucent, flexible material is required.

1 - 3 4 - - - - - -

**CELORON** — Continental-Diamond Fibre Co., Newark, Del. Resinous base, thermosetting; furnished in molded parts and laminated forms, for machining into parts; corrosion resistant; resistant to shock; high tensile and dielectric strength; low moisture absorption; high heat resistance and abrasion resistance; takes high polish. Grade C (canvas base) used for heavy-duty gears. Type L (linen base) used for small gears of fine pitch and narrow face, and intricate punchings.

**CORPRENE**—Armstrong Cork Co., Lancaster, Pa. Compounds of cork and various synthetic rubbers. Two dozen types, having a wide range of physical properties; furnished in sheet, cut gasket and molded forms. Impervious to liquids and gases; highly resistant to deterioration by oils, solvents and most other liquids, gases, corona and weather; high and low coefficients of friction, high and low degrees of compressibility, lateral flow, etc.; available to meet specific requirements. Used as gaskets, packings, washers, valve disks, feed rolls, polishing wheels, airplane walkways, diaphragms, friction and vibration pads, etc.
*See advertisement, Page 89-D*

1 - 3 - 5 - - - - - -

**CRYSTALITE**—Rohm & Haas Co. Inc., Philadelphia. Acrylic base, thermoplastic; furnished in molding powder for compression and injection molding; corrosion resistant; resistant to shock; transparent; flexible; specific gravity 1.18; tensile strength 4000-6000 lbs. per sq. in.; available in colors and high polish. Used for unbreakable gage dial covers and moldings of all kinds.

## D

- - - 4 5 - - - 9 -

**DIAMOND** — Continental-Diamond Fibre Co., Newark, Del. Vulcanized fibre, bone-like material; furnished in sheets, rods and tubes, for machining, sawing or punching into parts; high tensile and dielectric strengths; low specific gravity; tough; pliable; impact resistant. Used for insulating members, bobbin heads, etc.

- - - - 5 - - - - 10

**DILECTENE**—Continental Diamond Fibre Co., Newark, Del. Resinous base plastic, furnished in sheet and rods for machining into parts; can be highly polished; is corrosion resistant, flexible, translucent and shatterproof; dielectric strength, 650 volts per mil; tensile strength, 10,500 lb. per sq. in.; low moisture absorption; nonflammable; used for electrical insulating parts, etc.

- - - 4 5 - - - - 10

**DILECTO** — Continental-Diamond Fibre Co., Newark, Del. Phenolic base, thermosetting; furnished in laminated sheets, rods and tubes, for machining or stamping into parts; dielectric strength 270-500 volts per mil; low moisture absorption; tensile strength 10,000-25,000 lbs. per sq. in.; corrosion resistant; heat resistance 290 degrees Fahr., available in colors; resistant to shock; takes high polish; impact resistant; insoluble. Used for electrical, thermal and mechanical insulating parts.

1 - 3 - 5 - - - - - -

**DUFELT**—Felters Co. Inc., Boston. Laminated felt and Neoprene. Various thicknesses and lamination arrangements. Corrosion resistant; high dielectric strength. Used for washers and strips for oil and grease retention where conditions do not permit use of plain felt seal. Petroleum resistant.
*See advertisement, Page 4-D*

1 - - - 5 - - - - 10

**DUREZ**—Durez Plastics & Chemicals Inc., North Tonawanda, N. Y. Phenolic base, thermosetting; powder form, for molding into parts; resistant to corrosion; high polish; low moisture absorption; heat resistance 350-550 degrees Fahr.; tensile strength 4000-7000 lbs. per sq. in.; available in colors; shock and abrasion resistant. Used for housings, handles, bases, knobs, electrical parts, small gears, frames, hoods, etc.
*See advertisement, Page 79-D*

1 - 3 - 5 - - - - - -

**DURITE**—Durite Plastics Inc., Frankford Sta., P. O., Philadelphia. Phenol-furfural and phenol-formaldehyde synthetic resins, heat-setting; available in crushed, pulverized or liquid form, for bonding hot or cold molding compound, plywood, veneer, cements, abrasive articles, etc.; or in powder form for hot press molding; possesses high heat and shock resistance; high tensile and dielectric strengths, corrosion resistance, nonflammability and low moisture absorption. Used for cabinets, housings, handles, keys, knobs, automotive ignition, etc.

## E

1 - - - 5 - - - - 10

**EBROK**—The Richardson Co., Melrose Park, Ill. Acid-resisting bituminous plastic for specific requirements including such parts as battery containers.
*See advertisement, Page 24-D*

- 2 - 4 - 6 - - - -

**EEL-SLIP**—Johns-Manville, New York. Asbestos fiber, graphite and rubber compound; heat resistant; high tensile strength; nonflammable. Used for bearings, suction box covers, etc.

- - - 4 5 - - - - 10

**ETHOCEL**—The Dow Chemical Co., Midland, Mich. Plastic granules, thermoplastic; furnished in granular form for injection and extrusion molding; dielectric strength 1500 volts per mil on .010-in. thickness; tensile strength 7000-8500 lbs. per sq. in.; heat resistance 130-150 degrees Fahr.; low moisture absorption, good dimensional stability, available in color; specific gravity 1.10-1.25; translucent; opaque; compressive strength 10,000-12,000 lbs. per sq. in. Used for articles when dimensional stability is required, etc.

## F

1 - - - - - - 7 - - 10

**FARLITE**—Farley & Loetscher Mfg. Co., Dubuque, Iowa. Phenolic and urea base, thermosetting; furnished in laminated sheets; for machining and stamping into parts; resistant to corrosion; high polish; low moisture absorption; impact resistant; translucent; available in colors; tensile strength 6000-8000 lbs. per sq. in.; dielectric strength 200-400 volts per mil. Used for sawed or stamped flat parts for light machine members.

1 - - - 5 - 7 - - -

**FARLOEX**—Farley & Loetscher Mfg. Co., Dubuque, Iowa. Fibrous synthetic core with laminated Bakelite surface, thermosetting; furnished in laminated sheets, for machining into parts; dielectric strength 200 volts per mil; resistant to corrosion; high polish; resistant to impact; low moisture absorption; tensile strength 5000-6000 lbs. per sq. in.; heat resistant 450 degrees Fahr. phenolic; 370, urea. Used for low voltage insulation with moderate strength.

1 2 - - - 6 - - - -

**FEATHERWEIGHT**—Keasbey & Mattison Co., Ambler, Pa. Magnesia blocks, pipe covering and cement. Combination of magnesia and asbestos in powder or molded form with exceptionally low thermal conductivity. Used as a thermal insulating material where temperature does not exceed 600 degrees Fahr.

1 - - - 5 - - - 9 -

**FELTERS CERTIFIED FELT** — Felters Co. Inc., Boston. Nonwoven felts to all S.A.E. and other specifications. Available either in the piece or cut to customer's requirements. Used for pads, bumpers, antisqueak and rattle parts, filters, polishing roll covering, shaft and bearing seals, etc. Petroleum resistant.
*See advertisement, Page 4-D*

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**FIBERGLAS**—Owens-Corning Fiberglas Corp., Toledo, O. Glass; furnished in flexible, semirigid and rigid forms; nonflammable; light in weight; high insulating value; resistant to corrosion; low moisture absorption; downy white in color. Used for electrical equipment, industrial insulation purposes and as filters in air conditioning equipment.

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**FIBESTOS**—Monsanto Chemical Co., Plastics Div., Springfield, Mass. Cellulose acetate; thermoplastic; furnished in sheet, laminated and powder forms or rods and tubes, for molding, machining, stamping or swaging into parts; resistant to corrosion; transparent; available in colors; flexible; tough; high polish; dielectric strength 540-1800 volts per mil; tensile strength 6000-6800 lbs. per sq. in. Used for safety glass, and compressible shims, couplings, gaskets, electrically insulated knobs and handles, light diffusing panels, and molded shapes of all descriptions.

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**FIRECRETE**—Johns-Manville, New York. A castable refractory (ceramic); furnished in powder for casting into parts; abrasion resistance, good; heat resistance, 2400 and 2800 degrees Fahr.; specific gravity, 110 lb. per cu. ft.; used for special shapes, door linings and other types of monolithic construction. Material can be quickly cast into any shape.

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**FORMICA**—Formica Insulation Co., Cincinnati. Resinous base, thermosetting; furnished in laminated form, for machining or stamping into parts; corrosion resistant; tensile strength is slightly less than cast iron; high dielectric strength; absorbs no oil; changes in dimensions only slightly as the result of moisture absorption. Used for insulating washers and bushings, punched parts in switches, automotive starting systems and all types of heavy-duty gears.

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Grade C: phenolic laminated fabric; thermosetting; furnished in laminated form and in rods or tubes; can be highly polished; corrosion resistant to acids and salts, not alkalies; flexible in thin sections; dielectric strength, 200 volts per mil in 1/16-inch thick; tensile strength, 10,000 lb. per sq. in.; heat resistance, 300 degrees Fahr.; used for silent gears.

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Grade XX: phenolic laminated paper; thermosetting; furnished in laminated form and in rods or tubes; can be highly polished; dielectric strength, 500 volts per mil; tensile strength, 12,000 lbs. per sq. in.; heat resistance, 300 degrees Fahr.; available in natural and black; low moisture absorption; used for insulation for electrical equipment.
*See advertisement, Page 61-D*

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**FRANKLIN** — Franklin Fibre-Lamitex Corp., Wilmington, Del. Hard vulcanized fibre; furnished in laminated sheets, rods or tubes; for machining and stamping; dielectric strength 200-400 volts per mil of thickness; tensile strength 12,000-15,000 lbs. per sq. in.; specific gravity 1.3-1.46; compressive strength 38,000-42,000 lbs. per sq. in.; nonflammable. Used for electrical insulation.

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**FYBEROID** — Wilmington Fibre Specialty Co., Wilmington, Del. Paper base; furnished in sheet form, for machining or stamping into parts; dielectric strength 200-400 volts per mil; tensile strength 5000-8000 lbs. per sq. in.; flexible; abrasion and corrosion resistant. Used for insulation on motors, generators, automotive ignition starters, etc.

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**GARIT**—Garfield Mfg. Co., Garfield, N. J. Thermosetting, cold molded plastic; corrosion resistant; dielectric strength, 50-60 volts per mil; tensile strength, 1200 lb. per sq. in.; heat resistance, 450 degrees Fahr.; moisture absorption, 2.4 per cent; nonflammable; compressive strength, 7500 lb. per sq. in.; used for molded insulation for electrical equipment.

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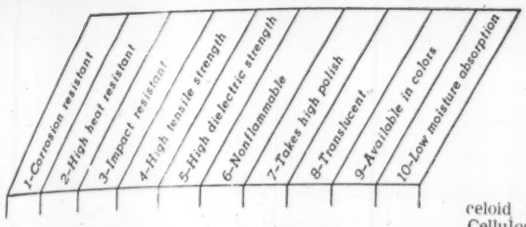
**GASKOFELT**—Western Felt Works, Chicago.




Compact combination of felt with an oil resistant rubber compound of great density and high tensile strength. Used for gasketing in connection with oil, steam, hot or cold water; temperatures up to 250 degrees Fahr.; pressures up to 225 lbs.

*See advertisement, Page 89-D*

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**GUMMON**—Garfield Mfg. Co., Garfield, N. J. Black, cold-molded; corrosion and heat resistant (450 degrees Fahr.); high dielectric strength; high polish; resistant to hot oil. Will not shrink, crack, warp or deteriorate with age. Takes high polish. Used for insulated parts such as wiring devices and other small units.

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**HARVEL**—Irvington Varnish & Insulator Co., Irvington, N. J.

Types 620-621; cold setting phenol aldehyde synthetic resin cement for cable splices, stop joins and oiltight terminals. Applied as a liquid which polymerizes at ordinary temperatures whether exposed to air or not, into a firm, enduring, infusible insulation. Material is flame-resistant, will not melt or soften after setting, and is not affected by acid and alkali solutions; electrical properties of dielectric strength, dielectric constant and power factor are extremely favorable.

Type 612-C; phenol-aldehyde synthetic resin insulating varnish; cannot soften or throw out and when cured is neither affected by acids or alkali solutions; highly resistant to transformer and lubricating oil, and maintains insulating qualities at elevated temperatures.

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**HASKELITE**—Haskelite Mfg. Corp., Chicago. Plastic-bonded plywood; light weight; high strength; elastic; hard; bendable into desired forms and shapes. Used for airplanes, buses, street cars, railways, radio cabinets and speakers, passenger cars, etc.

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**HEMIT** — Garfield Mfg. Co., Garfield, N. J. Cold-molded, gray-white refractory material; corrosion resistant; heat resistance 1100-1500 degrees Fahr.; low moisture absorption when impregnated; high dielectric strength; nonflammable. Used for interior parts of heating devices, or where a molded part must withstand an arc.

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**HERESITE**—Heresite & Chemical Co., Manitowoc, Wis. Phenolic resin, thermosetting; furnished in rods or tubes, powder or in laminated form, for molding, casting, and machining; corrosion, heat and impact resistant; high tensile and dielectric strengths; nonflammable; available in colors; translucent; low moisture absorption. Used for rayon machine parts and electrical equip-

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**HYCAR**—The Hydrocarbon Chemical & Rubber Co., Akron, O. Butadiene copolymer type of synthetic rubber thermosetting; furnished in crude sheet form ready for compounding into any type of stock for further processing by molding, extruding, calendering, etc. Type O.R. has excellent oil, heat, abrasion and aging resistance; excellent flex life; tensile strength up to 4000 lb. per sq. in., with elongation of 60 per cent. Adaptable to temperature range of 200-300 degrees Fahr.; low moisture absorption; specific gravity, 1. Used for gaskets, tubing, vibration insulators, packings, hose printing rollers and printing rubbers, etc. Can also be compounded to ebonite hardness with 100 degrees Fahr. higher softening point than obtainable in natural hard rubber. Also available in latex form.

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**HY-TEMP**—Keasbey & Mattison Co., Ambler, Pa. Diatomaceous earth and asbestos base; combination heat insulating blocks, cements and pipe covering; furnished in powder or molded form; good corrosion resistance; rigidity; high heat resistance; low moisture absorption; nonflammable; and low thermal conductivity. Used for thermal insulation up to 1900 degrees Fahr.

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**INCELOID**—American Products Mfg. Co., (Inceloid Co. Inc., subsidiary) New Orleans. Cellulose derivative, thermoplastic; furnished in sheet and laminated form for casting into parts; corrosion and heat resistant; can be highly polished; flexible; high dielectric strength; low moisture absorption, available in colors; shatterproof. Used for electrical insulation, laminating work, etc.

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**INDUR**—Reilly Tar & Chemical Corp., Indianapolis. Phenolic base, thermosetting; furnished in powder form, for molding into parts; tensile strength 8560 lbs. per sq. in.; high dielectric strength; nonflammable; low moisture absorption; corrosion resistant; available in colors; specific gravity 1.37±. Used for instruments and machine accessories including insulating panels, knobs and handles, gears, etc.

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**INDUR VARNISH**—Reilly Tar & Chemical Corp., Indianapolis. Phenolic base, thermosetting; for molding into parts; high dielectric and tensile strengths; nonflammable. Used for laminated gears.

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**INSULKOTE** — Johns-Manville, New York. Weatherproof coating for use over insulation of duct and other exposed equipment; corrosion resistant; heat resistant; low moisture absorption.

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**INSUROK**—The Richardson Co., Melrose Park, Ill.

Thermosetting type; furnished in laminated sheets, rods and tubes for machining into parts, or as finished molded parts; corrosion resistant; low moisture absorption; high tensile strength; resistant to shock; comparatively low specific gravity. Used for gears, bearings, electrical insulation. Available in different grades.

Thermoplastic type; furnished in molded parts; high dielectric strength; low moisture absorption; high tensile strength; low specific gravity. Available in color.

Transiucent type; urea or phenolic base, thermosetting; in laminated sheets and fabricated parts, for signs, displays, rear illumination and changeable background signs, coin operated machine cabinet parts, etc. Material is translucent, does not support combustion, and has low moisture absorption.

*See advertisement, Page 24-D*

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**IRVINGTON (Varnish Fiberglas)** — Irvington Varnish & Insulator Co., Irvington, N. J. Glass cloth woven from continuous fiber and coated with high heat resisting black or clear insulating varnish; high heat and moisture resistant; high dielectric strength. Coating specially developed for use with Fiberglas to further increase mechanical strength, by giving greater resistance to impact and abrasion.

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**IRV-O-LITE**—Irvington Varnish & Insulator Co., Irvington, N. J. Thermoplastic, furnished in rods or tubes; abrasion resistant; corrosion resistant to 30 per cent acids or alkalis; very flexible; dielectric strength 750 volts per mil; tensile strength 2850 lbs. per sq. in.; softens above 300 degrees Fahr.; slow burning; available in color; translucent, transparent and opaque. Used for electrical insulation.

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Type XTE-30; extruded tubing with outstanding mechanical strength, better tear resistance, greater solvent resistance, heat resistance and more fireproof; has good mechanical, chemical and electrical characteristics; flexible; smooth; and available in colors. Used for electrical appliance, automobile, aircraft and radio parts.

Type XTE-100; electrical insulating tubing with all advantages offered by the extrusion process of smooth inside and outside walls, great flexibility and resistance to mechanical wear and chemical deterioration; dielectric strength (dry), 750 volts per mil; tensile strength, 2000 lb. per sq. in.; with high resistance to tear and abrasion.

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**IRV-O-VOLT**—Irvington Varnish & Insulator Co., Irvington, N. J. An oleo-resinous varnished inside and out tubing, in the following types: lacquer-coated cotton tubing, and oil varnish treated cotton tubing; heat resistance, 450 degrees Fahr. for 15 min.; good moisture resistance and ageing properties; extreme flexibility with high tensile strength; available in colors; used for applications involving high temperature baking, or continuous exposure to elevated temperatures and for apparatus into which hot potting compounds are poured for sealing purposes.

## K

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**"K" FELT**—American Felt Co., New York. Kapok fiber 45, cotton 30 and wool 25; furnished in rolls approximately 24 yards long and 72 inches wide, in thicknesses from ⅛-inch to 1 inch in ⅛-inch increments, in white; flameproof; mothproof; low moisture absorption. Used for insulating material and numerous other purposes. Also available in S.A.E. felt specifications.

*See advertisement, Page 85-D*

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**KNIGHT-WARE**—Maurice A. Knight, Akron, O. Acid-proof chemical stoneware obtainable in a wide variety of special shapes and sizes; inert to corrosion of all chemical solutions or gases except hydrofluoric acid and caustic soda; very hard; excellent dielectric strength; resistant to heat but not sudden heat changes. Used for valves, pipes, jars, tanks, filters, towers, etc.

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**KOMPO-KORK**—Korfund Co. Inc., Long Island City, N. Y. Plates of finely granulated compressed cork with an oxidized linseed oil binder and burlap backing; corrosion and shock resistant; low moisture absorption. Used where irregularly shaped plates are required for isolating light machinery to combat vibration.

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**KORFUND**—Korfund Co. Inc., Long Island City, N. Y. Resilient mat of pure natural cork, steel bound and oil treated; corrosion and shock resistant; unaffected by acids and temperature changes; low moisture absorption. Used as machine bases to reduce vibration. Another isolator developed by the company is identical in construction, but is bound with asphalt and felt.

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**KORK-RUBBER**—Korfund Co. Inc., Long Island City, N. Y.—Plates of finely granulated cork and rubber particles compressed together; corrosion and shock resistant; low moisture absorption. Used for vibration dampening of light machines.

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**KOROSEAL**—B. F. Goodrich Co., Akron, O. Synthetic elastic; furnished in various consistencies from jelly to bone-like hardness; corrosion and shock resistant; available in colors. Jelly is used for making molds for plastic casts, but other compounds sold only as finished products. Superior to rubber in flexing, oxidation and penetration of moisture or gases; does not swell in oil. Available in molded and extruded forms; also applied as coating to paper and fabric.

## L

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**LAMITEX**—Franklin Fibre-Lamitex Corp., Wilmington, Del. Phenolic base, thermosetting; furnished in laminated sheets, rods or tubes, for machining and stamping into parts; corrosion resistant; high polish; dielectric strength 500 volts per mil; tensile strength 15,000 lbs. per sq. in.; heat resistance 300 degrees Fahr.; low moisture absorption; nonflammable; compressive strength 35,000 lbs. per sq. in. Used for electrical insulation.

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**LORD**—Lord Mfg. Co., Erie, Pa. Rubber-bonded-to-metal, for a variety of uses including shear-type mountings for vibration isolation. Typical applications include aircraft automotive, and marine engines; motors, pumps, compressors, machinery, radio equipment, instruments, etc., where vibration is encountered.

*See advertisement, Page 21-D*

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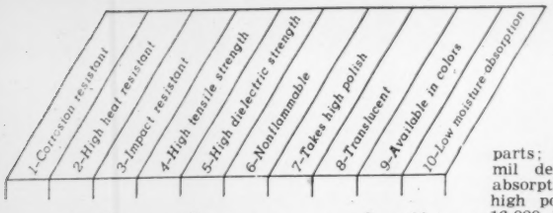
**LUCITE**—E. I. du Pont de Nemours & Co. Inc., Wilmington, Del. Polymethyl-methacrylate base, thermoplastic; furnished in powder or sheets, rods and tubes, for molding and machining into parts; transparent, translucent; high dielectric strength; available in colors; resistant to shock; low moisture absorption; high polish; resistant to corrosion; tensile strength 5800-8000 lbs. per sq. in.; heat resistance 150-203 degrees Fahr. Used for panels, knobs, models, safety guards, dials and gage glasses, airplane enclosures and automatic parts.

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**LUMARITH**—Celluloid Corp., New York. Cellulose acetate base, thermoplastic; furnished in sheets, powder or rods and tubes; powders for compression and injection molding. Available in colors; tensile strength 3000-15,000 lb. per sq. in.; dielectric strength 500-2000 volts per mil; high polish; flexible; resistant to shock and corrosion. Used for instrument dials and housings, radio grills, panels, airplane windshields, handles, knobs, register wheels, key buttons, electrical insulated parts, steering wheels, instrument panel knobs, etc.

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**LUMARITH PROTECTOID** — Celluloid Corp., New York. Cellulose acetate base, thermoplastic; furnished in sheet and rolls or reels in thicknesses of .0007-0.020, for laminating, swedging, drawing, or stamping into parts; abrasion and corrosion resistant; flexible; dielectric strength 700-2500 volts per mil; tensile strength 4500-11,000 lb. per sq. in.; heat resistant to 275 degrees Fahr.; slow burning to nonflammable; transparent. Used for laminated slot insulation paper for motors, wire insulation, formed insulators, etc.

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**LUSTRON**—Monsanto Chemical Co., Plastics Div., Springfield, Mass. Polystyrene; thermoplastic; styrene base; furnished in powder for molding into parts; abrasion resistance fair; can be highly polished; corrosion resistant; dielectric strength 500-700 volts per mil; tensile strength 5500-8500 lbs. per sq. in.; low moisture absorption; available in color; specific gravity 1.07; clear to opaque. Used for electrical insulating parts, etc.

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**LUZERNE HARD RUBBER**—The Luzerne Rubber Co., Trenton, N. J. Hard rubber, thermoplastic; furnished in sheets, rods or tubes, for molding and machining into parts; high polish; corrosion resistant to acids and alkalies; dielectric strength 6 x $10^{2}$ megohms constant at 28.8 degrees Cent.; tensile strength 3500-9000 lbs. per sq. in.; heat resistant to 120 degrees Fahr.; available in some colors; specific gravity 1.24; compressive strength 8000-12,000 lbs. per sq. in. Used for molded machine parts.

## M

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**MAKALOT**—Makalot Corp., Boston. Synthetic resinous base; furnished in powder form and also as varnish and sheet, for molding into parts; high tensile and dielectric strength; low moisture absorption; heat, shock and abrasion resistant; nonflammable; flowing and covering characteristics eliminate sticking troubles.

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**MARBLETTE** — Marblette Corp., Long Island City, N. Y. Cast phenolic resin furnished in sheets, rods, tubes and special castings to be fabricated into finished form; colors; opaque and translucent; mottled or plain; also "Crystle" (water-clear transparent); nonflammable; insoluble; infusible; noncorrosive; odorless; high tensile and dielectric strengths; high polish; easily machined

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**MICABOND** — Continental-Diamond Fibre Co., Newark, Del. A built-up Mica material; furnished in sheets and tubing, for machining and forming into parts; heat resistant; high dielectric and tensile strength; nonflammable; low moisture absorption. Used for V-rings, washers, segments and various special shapes.

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**MICAROK**—The Richardson Co., Melrose Park, Ill. Sheet mica, furnished in laminated sheets for stamping into parts; abrasion and corrosion resistant; flexible to some extent; dielectric strength high; heat resistance, good; low moisture absorption; nonflammable; specific gravity, 2.25-2.65 according to grade; used in electrical applications when heat and arc resistance are factors.

*See advertisement, Page 24-D*

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**MICARTA**—Westinghouse Electric & Mfg. Co., Trafford, Pa. Phenolic base, thermosetting; furnished in laminated sheet, rods or tubes; for molding, machining or stamping into parts; dielectric strength 50-700 volts per mil depending upon grade; low moisture absorption; resistant to shock, corrosion; high polish; flexible; tensile strength 6000-16,000 lbs. per sq. in.; available in colors; translucent; heat resistance 230; nonflammable; specific gravity 1.32-1.8 depending upon grade. Used for bearings, gears, bushings, washers, thermal and electrical insulation and parts exposed to acids, alkalies and common solvents.

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**MYCALEX**—General Electric Co., Pittsfield, Mass. Ceramic base thermoplastic; furnished in sheet, rods or tubes; for molding or machining into parts; abrasion resistance, moderate; can be highly polished; corrosion resistant; dielectric strength, 350 volts per mil; tensile strength, 5000-7000 lb. per sq. in.; heat resistance, 600 degrees Fahr.; low moisture absorption; nonflammable; available in gray only; opaque; compressive strength, 22,000-30,000 lb. per sq. in.; used for electrical insulation; switches, etc.

*See advertisement, Page 67-D*

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**NATIONAL CARBON** — National Carbon Co. Inc., Cleveland. Carbon or graphite in amorphous or graphite form; made in a variety of shapes; molded, extruded or machined into parts. In graphitic form carbon possesses excellent lubricating properties; highly resistant to most acids, alkalies and solvents. Used for sleeve bearings, packings, threaded parts, nozzles for corrosive liquids, etc.

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**NATIONAL FIBRE**—National Vulcanized Fibre Co., Wilmington, Del. Converted cotton cellulose, chemically pure, tough horn-like material; furnished in hard or flexible form in sheets, rolls, tubes, rods and fabricated shapes; high dielectric and mechanical strengths; resistant to abrasion and shock; easily formed and machined; light in weight. Used for gears, valve disks, gaskets, washers, bobbin hears, electrical insulation etc.

*See advertisement, Page 83-D*

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**NATIONAL SWITCH INSULATION**—National Vulcanized Fibre Co., Wilmington, Del. Combination laminated Bakelite core with vulcanized fiber surfaces; available in sheets and fabricated shapes; high tracking (arc) resistance combined with rigidity and minimum warpage; high dielectric and mechanical strengths; low moisture absorption; easily stamped and fabricated. Used in switches to support and insulate current-carrying parts.

*See advertisement, Page 83-D*

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**NEOPRENE**—E. I. du Pont de Nemours & Co. Inc., Wilmington, Del. Chloroprene rubber; available as hose, wire, cable, sheets, tank linings, gaskets, packing, tubing, belting, diaphragms, industrial truck tires and molded goods. Used as binder for cork and asbestos. Is employed to impregnate or coat canvas, duck or other fabrics. Strength, abrasion resistance, resilience and elasticity of rubber; resistance to deterioration from contact with oils, greases, gasoline, heat, chemicals, sunlight and ozone; corrosion resistant; will not support combustion; low moisture absorption; tensile strength 4000 lbs. per sq. in.; available in colors. Used for machine applications where rubber characteristics are required but where the product is to be subjected to deteriorating influences.

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**NIGRUM**—Bound Brook Oil-less Bearing Co., Bound Brook, N. J. Impregnated hard wood bearings and washers; northern hard maple impregnated with specially prepared lubricant; used in loose pulleys, automotive, textile, foundry equipment, etc.

*See advertisement, Page 81-D*

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**NITRON**—Monsanto Chemical Co., Plastics Div., Springfield, Mass. Cellulose nitrate; thermoplastic; furnished in sheets, rods and tubes, or in laminated form, for machining, molding, stamping, swedging or blowing (steam) into parts; corrosion resistant; translucent; available in colors; flexible; dielectric strength 750-900 volts per mil; tensile strength 6000-9000 lbs. per sq. in.; low moisture absorption. Used for sight glasses, safety glass, oilproof insulation, dial covers, knobs, handles and structural models for strain study.

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**NYLON**—E. I. du Pont de Nemours & Co. Inc. Arlington, N. J. Thermoplastic, furnished as monofilament for cutting into parts; abrasion resistance far superior to hog bristle; tough rather than brittle; resistant to many chemicals; very flexible; dielectric strength (volts per unit) 5 at 1000 cycles, 20 degrees Cent.; tensile strength, 51,000 lb. per sq. in.; melting point, 264 degrees Cent.; nonflammable; produced in black and white; density, 1.14; translucent; used for brush bristles.

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**OHMOID**—Wilmington Fibre Specialty Co., Wilmington, Del. Phenolic base, thermosetting; furnished in laminated sheets, rods and tubes, for machining or stamping into parts; dielectric strength 200-700 volts per mil; moisture absorption 2 per cent; insoluble in ordinary solvents; high polish; corrosion resistant; tensile strength 10,000-14,000 lbs. per sq. in.; heat resistance 250-300 degrees Fahr. Used for electric and mechanical insulation.

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**OPALON**—Monsanto Chemical Co., Plastics Div., Springfield, Mass. Cast phenolic; thermosetting; furnished in sheets, rods and tubes, or laminated form; for casting and machining into parts; translucent; dielectric strength 250-700 volts per mil; corrosion resistant; tensile strength 6000-11,000 lbs. per sq. in.; high polish; moisture absorption .05-.5 per cent; available in colors. Used for safety shields, clock and radio cases, electrically insulated knobs and handles and structural models for strain study, and decorative trim.

## P

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**PANELYTE**—The Panelyte Div., St. Regis Paper Co., New York. Laminated phenolic paper or fabric base, with surface of urea-formaldehyde type in colored grades; supplied in sheet, strips, rod, tube and molded form; also fabricated to size; good mechanical strength; resistant to acids and alkalies; low moisture absorption; lightweight; specific gravity 1.38. Used for refrigerator door panels, breaker strips, radio and electrical insulation, gears, pinions and structural parts; also in decorative grades for table tops, panels, etc.

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**PEERLESS**—National Vulcanized Fibre Co., Wilmington, Del. Converted cotton cellulose, chemically pure, fish paper insulation; furnished in sheets and rolls; high dielectric strength combined with toughness, springiness and good bending properties. Used extensively for generator and motor insulation and various other electrical applications.

*See advertisement, Page 83-D*

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**PHENOLITE**—National Vulcanized Fibre Co., Wilmington, Del. Laminated Bakelite; furnished with base of paper, cloth or asbestos in sheets, rods, tubes and fabricated shapes; also laminated with rubber sheet; high dielectric and mechanical strengths; low moisture absorption; heat resistant; infusible; resistant to acids, solvents and oils; high resistance to wear and impact; machinable. Used in electrical, mechanical and chemical applications for silent gears, bearings, bushings, washers, valve disks, terminal strips, etc.

*See advertisement, Page 83-D*

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**PLASKON**—Plaskon Co. Inc., Toledo, O. Urea formaldehyde base, thermosetting; furnished in powder form, for molding into parts; translucent; tensile strength 8000-13,000 lbs. per sq. in.; available in colors; corrosion resistant; high polish; dielectric strength 500-700 volts per mil (60 cycles); heat resistance 175 degrees Fahr.; resistant to shock; low moisture absorption. Used for housings, trim, knobs, dials, etc.

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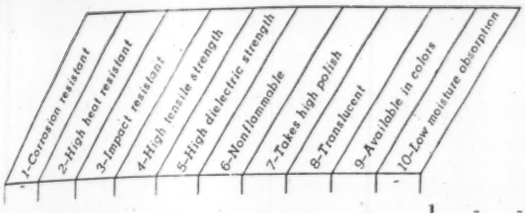
**PLASTACELE**—E. I. du Pont de Nemours & Co. Inc., Wilmington, Del. Cellulose acetate base, thermoplastic; furnished in powder, sheets, rods and tubes, for machining and molding into parts; available in colors; transparent; resistant to shock; high polish; corrosion resistant; flexible; dielectric strength 700-1000 volts per mil; tensile strength 3000-8000 lbs. per sq. in.; heat resistance 185-250 degrees Fahr. Used for machine guards, models, control panels, dials, knobs, steering wheels, safety glass screens, etc.

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**PLEXIGLAS**—Rohm & Haas Co. Inc., Philadelphia. Acrylic base, thermoplastic; furnished in sheets and rods; corrosion and shock resistant; transparent; flexible; specific gravity 1.18; tensile strength 7000-9000 lbs. per sq. in.; available in colors; high polish. Used for unbreakable inspection windows.

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**PLYMETL**—Haskelite Mfg. Co., Chicago. Plastic-bonded plywood, sheet metal bonded to one or both faces; has stiffness, rigidity; lightweight; metal on both faces insuring freedom from warpage. Types available for different purposes are galvannealed steel, stainless steel, aluminum, copper, chrome zinc, chrome steel, porcelain, etc. Used for applications in the automotive and aircraft fields.

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**POLAROID** — The Polaroid Corp., Cambridge, Mass. Light-polarizing glass and film. Principal property is 99.5 per cent polarization of transmitted light, uniformly over large area. Used for camera filters, polarizing attachments for microscopes, refractometers and other scientific instruments. Also for model structures to determine strain, three-dimensional motion picture apparatus, glareless auto headlights, etc.

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**PRYSTAL**—Catalin Corp., New York. Phenolic base, thermosetting; furnished in sheets, rods or special castings; nonflammable; transparent; low moisture absorption; high dielectric strength; corrosion resistant; available in color; insoluble; shatterproof; high refractory index. Used for applications where it is necessary to replace glass.

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**PVA**—E. I. du Pont de Nemours & Co., Wilmington, Del. Thermoplastic, polyvinyl alcohol; furnished in powder form for molding and casting; highly flexible; low dielectric strength; heat resistance up to 212 degrees Fahr.; takes color; shatterproof; specific gravity 1.3 powder; translucent; resistant to organic solvents. Used for oil resistant gaskets, tubes, rollers, etc., as well as protective coatings on metal parts.

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**PYRALIN**—E. I. du Pont de Nemours & Co. Inc., Wilmington, Del. Nitrocellulose base, thermoplastic; furnished in sheets, rods and tubes, for machining into parts; transparent; available in colors; shock and corrosion resistant; high polish; flexible; dielectric strength 300-750 volts per mil; tensile strength 5000-10,000 lbs. per sq. in. Used for handles, gage glasses, instrument covers, models, safety glass screens, etc.

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**PYREX**—Corning Glass Works, Corning, N. Y. Trademark indicates manufacture by above. Glass products such as tubing, cylinders, sheets, molded parts, etc., covering a great range of desirable chemical, physical and optical properties such as heat resistance, low or high thermal conductivity, low or high coefficient of expansion, excellent corrosion resistance, no appreciable moisture absorption, nonflammable, ability to bond to metal. Over 250 glasses regularly melted. Specific properties of typical product, PYREX brand piping, as follows: Linear coefficient of expansion .0000018 inches per deg. Fahr. between 66 degrees Fahr.-660 degrees Fahr. Thermal conductivity 8.1 B.t.u./sq. ft. /hr./in./° Fahr. at 77 degrees Fahr. Tensile strength from 6000 to 10,000 lbs. per sq. in.; dielectric strength 2700 KV per inch.

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**PYROFLEX** — Maurice A. Knight, Akron, O. Depolymerized colloidal resin base, thermoplastic; furnished in lump or sheet form; applied by dipping or flame cementing sheets to parts; corrosion resistant; high dielectric strength; low moisture absorption. Good bonding material where temperatures are not too high.

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**PYROPLAX**—Cutler-Hammer Inc., Milwaukee. Asbestos base; furnished in cold-molded pieces; heat resistance 800-1000 degrees Fahr.; nonflammable; dielectric strength 40 volts per mil; resistant to corrosion and abrasion. Used for machine parts where resistance to high temperature is needed.

## R

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**RESILON**—United States Stoneware Co., Akron, O. Resinous thermoplastic; furnished in sheets and lumps to be molded and cast into machine parts; corrosion resistant; flexible; high dielectric strength; tensile strength; heat resistant; shatterproof. Used for lining parts to resist corrosive attack.

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**RESINOX**—Monsanto Chemical Co., Plastics Division, Springfield, Mass. Phenolic molding compounds, in standard and special formulas, thermosetting; heat-resistant; specific gravity 1.44; flexural strength 9200 lbs. per sq. in.; tensile strength 6800 lbs. per sq. in.; impact strength 2.5 ft. lbs. per sq. in.; water absorption .63 per cent by weight. Used in electrical equipment, large housings, radio cabinets, etc. This tradename also refers to phenolic impregnating and treating resins.

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**RESISTOFELT**—Western Felt Works, Chicago. A lamination of high-grade wool felt and Neoprene. Used on revolving shafts; the felt lubricates the shaft and prevents entrance of dust; the Neoprene prevents passage of oil.

*See advertisement, Page 87-D*

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**RESNPREST**—Plylock Corp., subsidiary of M & M Wood Working Co., Portland, Ore. Phenol-formaldehyde bonded plywood; thermosetting; strong by unit weight; panel ¼-inch thick and 12-in. sq. weighs approximately 12 oz., and supports over 400 lb. Cross-ply construction of material makes it splitproof and nails and screws can be fastened to very edge with safety. Resists heat and cold; and has low moisture absorption. Used wherever rigidity and lightweight is needed.

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**REVOLITE**—Atlas Powder Co., Zapan-Keratol Div., Stamford, Conn. Cloth base impregnated with Bakelite resin; in either laminated or single ply form; heat resistant; high dielectric strength; corrosion resistant; low moisture absorption; impact resistant. Used for cable wrappings, diaphragms for pumps and valves, gaskets and flexible connections for machinery such as pulverizers, and coated asbestos laundry roll covers for flat work ironers.

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**RUB-EROK**—Richardson Co., Melrose Park, Ill. Special rubber furnished in sheet form; corrosion resistant; high dielectric strength; low moisture absorption; low loss factor. Used for electrical insulation.

*See advertisement, Page 24-D*

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**RUB-TEX**—The Richardson Co., Melrose Park, Ill. Hard rubber molded into parts, particularly desirable for electrical, heat and cold insulation; for industrial uses.

*See advertisement, Page 24-D*

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**RYERTEX**—Joseph T. Ryerson & Son Inc., Chicago. A nonmetallic bearing material designed for use with water lubrication primarily; high shock resistance; suitable for bearing loads to 5000 lbs. per sq. in.; resistant to acids and mild alkalies.

## S

**SAFLEX**—Monsanto Chemical Co., Plastics Division, Springfield, Mass. Polyvinyl acetal thermoplastic sheet material, used as an interlayer in laminated safety glass; extremely tough from temperatures below zero to over 120 degrees Fahr. Has great flexibility and rubberiness.

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**SARAN**—The Dow Chemical Co., Midland, Mich. Crystalline, thermoplastic, fibrous, aliphatic chloride, polymeric base; furnished in special extruded and molded fabricated forms; corrosion resistant; very tough and flexible; tensile strength up to 50,000 lb. per sq. in. (extruded); no moisture absorption; abrasion resistant; high polish; high dielectric strength; shatterproof; nonflammable, available in color; transparent to opaque; used for moldings, gaskets, packing, tubing, belting, etc.

*See advertisement, Page 3-D*

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**SELFVULC**—Self-Vulcanizing Rubber Co. Inc., Chicago. Self, cold curing gum rubber; furnished in plastic or liquid form; resistant to corrosion and abrasion; tensile strength 2000 lbs. per sq. in.; resistant to shock; flexible; heat resistance 212 degrees Fahr.; low moisture absorption; available in colors. Used in machines as a sound deadener, insulation and waterproofing.

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**SIRVENE**—Chicago Rawhide Mfg. Co., Chicago. Synthetic rubber compounds molded into parts; resistant to oils and heat, oxidation and weather. Used for sealing oils and greases, packings, gaskets, covers and special parts.

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**SIRVIS**—Chicago Rawhide Mfg. Co., Chicago. Special tanned abrasive and heat resisting leather. Used for all types of packings, gaskets and mechanical leather parts.

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**SPAULDING ARMITE** — Spaulding Fibre Co. Inc., Tonawanda, N. Y. Hard vulcanized, fibrous material; sheets and laminated forms for machining, stamping or forming into parts; flexible; dielectric strength 200-550 volts per mil; compressive strength 40,000 lbs. per sq. in.; abrasion and corrosion resistant; tensile strength 9000-15,000 lbs. per sq. in.; available in colors; high polish.

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**SPAULDING FIBRE**—Spaulding Fibre Co., Inc., Tonawanda, N. Y. Hard vulcanized fibrous material; sheet and laminated forms or rods and tubes, for machining, stamping or forming into parts; dielectric strength 150-400 volts per mil; tensile strength 9000-15,000 lbs. per sq. in.; flexible; abrasion and corrosion resistant; available in colors; resistant to shock. Used for mechanical applications where toughness, light weight and machining and forming properties are essential.

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**SPAULDITE**—Spaulding Fibre Co. Inc., Tonawanda, N. Y. Phenolic base, thermosetting; furnished in sheet and laminated rods and tubes for machining or stamping into parts; dielectric strength 700 volts per mil; low moisture absorption; high polish; corrosion and heat resistant (220 degrees Fahr.); resistant to shock. Used where resistance to moisture and chemicals, appearance and permanence are essential.

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**SPAULDO**—Spaulding Fibre Co. Inc., Tonawanda, N. Y. Fibrous material; furnished in sheet form for machining or stamping into parts; flexible; dielectric strength 300 volts per mil; heat resistance 220 degrees Fahr.; high polish; corrosion resistant; tensile strength 8000-16,000 lbs. per sq. in.; resistant to shock. Used for applications where flexibility and toughness in both grain directions are essential.

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**SWEET HOME BRAND**—Am-mex Sales Co. Inc., Buffalo. Phenolic resin-bonded, thermosetting plywood, machined into parts. Used for aircraft cabinets, instrument panels, bases, bodies, boats, etc.

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**STYRON A-50 and A-200**—The Dow Chemical Co., Midland, Mich. Thermoplastic; furnished in powder for molding; abrasion resistant, high clarity; corrosion resistant; dielectric strength 5000 volts per mil at 1 mil, 500 volts per mil at 125 mil; tensile strength, ult., to 10,000 lbs. per sq. in.; low moisture absorption; low flammability; available in color; transparent. Used for insulators, decorative articles, structural parts, general injection molding, etc.

*See advertisement, Page 3-D*

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**SYNTHANE**—Synthane Corp., Oaks, Pa.

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Grades C and C-CR; Phenolic; thermosetting; furnished in laminated sheets, and rods or tubes for molding, machining, stamping and sawing into parts; abrasion and corrosion resistant; dielectric strength 200 volts per mil (1/16-inch thickness); tensile strength 9500 lbs. per sq. in.; heat resistance 250 degrees Fahr.; low moisture absorption; nonflammable; shatterproof; specific gravity 1.36. Used for gears, cams, structural parts, rollers, valve disks, corrosion resistant piping, gaskets and thrust washers.

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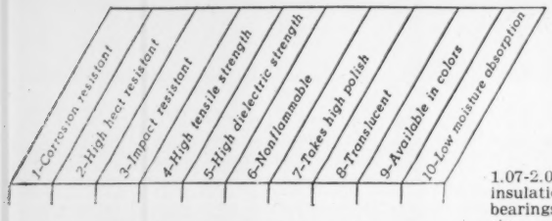
Grade XX; Phenolic; thermosetting; furnished in laminated sheets, rods or tubes




for machining, stamping and sawing into parts; abrasion and corrosion resistant; dielectric strength 700 volts per mil; tensile strength 8000 lbs. per sq. in.; heat resistance 250-300 degrees Fahr.; low moisture absorption; shatterproof; specific gravity 1.36. Used for radio panels, coil forms, switch and relay parts, lead-in bushings, terminal blocks and insulating parts.

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Grade XP: Phenolic; thermosetting; furnished in laminated sheets for machining, stamping and sawing into parts; abrasion resistant; not as corrosion resistant as foregoing grades; dielectric strength 700 volts per mil; tensile strength 8000 lbs. per sq. in.; heat resistance 250 degrees Fahr.; used for radio switch part punchings, condenser stator brackets, washers and relay insulation punchings.

*See advertisement, Pages 74-D 75-D*

## T

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**TAYLOR FIBRE** — Taylor Fibre Co., Norristown, Pa. Phenolic base, thermosetting; furnished in laminated sheet, rods or tubes for machining into parts; high polish; flexural strength 12,000-16,000 lbs. per sq. in.; dielectric strength 500 volts per mil; tensile strength 5000-9000 lbs. per sq. in.; heat resistance 300 deg. Fahr.; low moisture absorption; available in colors; impact resistant; brinell hardness 35-45. Used for gears, and insulating and binding material against moderate temperatures.

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**TEGIT** — Garfield Mfg. Co., Garfield, N. J. Tan colored, cold-molded plastic; corrosion resistant; high dielectric strength; low moisture absorption; heat resistance 300 degrees Fahr.; impact resistant; resists hot oil, boiling water and ordinary chemicals; will not shrink, crack, warp or deteriorate with age. Used for wiring devices and small insulated parts.

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**TEGO**—Resinous Products & Chemical Co., Philadelphia. A synthetic resin (adhesive) phenolic resin film, dry sheet. Has low moisture absorption, high density; used mainly in aircraft.

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**TENITE**—Tennessee Eastman Corp., Kingsport, Tenn.

I; cellulose acetate base, thermoplastic; furnished in granular and molding sheet form; available in clear transparent and colors, plain, variegated, translucent and opaque; high impact strength; high polish. Used for compression and injection molding decorative and industrial products, also extruded in form of strips, rods and tubes.

II; cellulose acetate butyrate base, thermoplastic; furnished in granular and molding sheet form; has greater dimensional stability than cellulose acetate plastic because of lower moisture absorption; contains less plasticizer than cellulose acetate plastic and the plasticizer used has greater retentivity; available in clear transparent and colors; plain, variegated, translucent and opaque; high impact strength; high polish. Used for compression and injection molding of decorative and industrial products, also extruded in form of strips, rods and tubes.

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**TENSILASTIC**—American Wringer Co., Woonsocket, R. I. Rubber feed rolls. Available in any size from ½-inch long and ½-inch in diameter to 300 inches long and 44 inches in diameter; any density from dead hard to very soft; compounded to meet mechanical and chemical requirements.

*See advertisement, Page 75-D*

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**TEXTOLITE** — General Electric Co., Plastics Dept., Pittsfield, Mass. Phenolic, urea, ethenna, cellulose bases, thermosetting and thermoplastic materials; furnished in sheets, laminated forms, and rods or tubes; compression and injection molded, machined and stamped into parts; abrasion and corrosion resistant; tensile strength, 3500-20,000 lbs. per sq. in.; dielectric strength 60-1000 volts per mil; heat resistance 140-450 degrees Fahr.; resistant to shock; flexible in some grades; available in color; takes high polish; translucent in some grades; specific gravity 1.07-2.03. Used for electrical or thermal insulation, structural parts, gears, cams, bearings, housings, knobs, decorative parts, etc.

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Cold Molded—Two types; nonrefractory material containing asphalt as a binder and asbestos as a filler and refractory containing cement and drying oils as a binder with an asbestos filler; cold molded at room temperatures and heat treated for strength and toughness; corrosion resistant; heat and arc resistant. Not recommended for parts requiring high electric strength or thin sections.

*See advertisement, Page 67-D*

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**THERMOPLAX**—Cutler-Hammer, Inc., Milwaukee. Bituminous base compounded with filler such as asbestos; cold-molded into parts; heat resistance 400-600 degrees Fahr.; nonflammable; dielectric strength 80-100 volts per mil; resistant to corrosion; high polish; tensile strength 2000-4000 lbs. per sq. in.; moisture absorption 2 per cent. Used for electrical and heat insulation.

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**THIOKOL**—Thiokol Corp., Trenton, N. J. Synthetic rubber, available in two types; furnished in powder or raw sheet form, corresponding to crude rubber; processed in manner similar to rubber; oil, corrosion and shock resistant. Used for hoses carrying oil or gasoline, gaskets, packing, pipeline rings, diaphragms, newspaper printing blankets, etc.

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**TRANSITE**—Johns-Manville, New York. Fireproof material in a variety of forms as hoods, dampers, baffles, electrical conduits where high dielectric strength is not required; resistant to corrosion; heat resistant; nonflammable.

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**TYGON**—United States Stoneware Co., Akron, O. Resinous thermoplastic; furnished in sheet, rod or tube form, for molding and extruding into parts; abrasion, heat, impact, and corrosion resistant; flexible; high dielectric and tensile strength; low moisture absorption; available in color; shatterproof; translucent. For use in oil and corrosion resistant coverings, gaskets, tubing, etc.

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**UFORMITE**—Resinous Products & Chemical Co., Philadelphia. A synthetic resin (adhesive) urea-formaldehyde; furnished in powder form; has low moisture absorption, high density; used in aircraft.

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**UNISORB**—Felters Co. Inc., Boston. Specially controlled felt for vibration absorption. Types and thicknesses available for most frequencies and loadings encountered in industrial field. Also types available for sound absorption. Petroleum resistant. A special brand cement is also available for use with this material in order to eliminate the need of any other form of hold down such as expansion bolts or lag screws. Holding strength in excess of 40 lbs. per sq. in. when used between the felt and steel, concrete or wood.

*See advertisement, Page 4-D*

## V

**VIBRACORK**—Armstrong Cork Co., Lancaster, Pa. Resilient board of cork granules; compressed and baked under pressure; long life and high resistance to deterioration. Material is made in three densities for vibration damping applications.

*See advertisement, Page 89-D*

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**VIBRO-PLATE**—Korfund Co. Inc., Long Island City, N. Y. Material has permanent elastic core, consisting of a combination of several resilient elements; corrosion and shock resistant; low moisture absorption. Used for pads to be placed under legs or bases of machines.

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**VICTOPAC**—Victor Mfg. & Gasket Co., Chicago. Compressed sheet packing with asbestos base for stamping or cutting by hand into parts; high corrosion resistance; flexibility; tensile strength 2500 lbs. per sq. in.; heat resistant; low moisture absorption; nonflammable; impact resistant; high compressive strength. Used for gasketing and packing.

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**VICTOPRENE**—Victor Mfg. & Gasket Co., Chicago. Synthetic elastic, thermosetting; furnished in sheet or molded form. Sheets may be stamped and blanked into parts; corrosion and heat resistant; tensile strength 1500 lbs. per sq. in.; low moisture absorption; shatterproof. Used as a gasketing material.

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**VICTOR**—Victor Mfg. & Gasket Co., Chicago.

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Asbestos sheet, asbestos fiber base; furnished in sheets for stamping or cutting into parts; corrosion resistant; flexible; tensile strength 300 lbs. per sq. in.; heat resistance 700 degrees Fahr.; nonflammable; specific gravity .9; high compressive strength; insoluble; some resilience. Used for packing, thermal insulation, and vibration absorption.

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Cork sheet; vegetable bark in sheet form for stamping and cutting into parts; corrosion resistant; flexible; heat resistance 180 degrees Fahr.; low moisture absorption; specific gravity .27; fair compressive strength; resilient. Used for fluid seals and vibration absorption.

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**VICTORITE**—Victor Mfg. & Gasket Co., Chicago. Vegetable fiber base, sheet packing furnished for stamping or cutting by hand into machine parts; flexible; tensile strength 3000 lbs. per sq. in.; heat resistance 200 degrees Fahr.; nonflammable; impact resistant; specific gravity .675; compressive strength 2000 lbs. per sq. in.; resilient. Used for gasketing and packing.

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**VINYLITE**—Carbide & Carbon Chemicals Corp., New York. Unfilled V Series; conjoint polymer of vinyl chloride and vinyl acetate; thermoplastic; furnished in sheets, rods or tubes, elastic sheeting, powder for molding, machining, heat forming, stamping or extruding into parts; corrosion resistant; takes high polish; flexible; available in colors; nonflammable; moderate tensile strength; dielectric strength 650 volts per mil. Used for machine cabinets, electrical fixtures, transparent windows, dials, drawing and calculating instruments, sound recording disks, etc.

Resins: Series "A" (polyvinyl acetate) granular form, and in solution, thermoplastic. Adhesives applied as hot melt or from solution for metal to metal, metal to glass, etc. Series "X" (polyvinyl acetal) in powder and sheet form, thermoplastic.

Laminating film for safety glass.

Series "Q" (polyvinyl chloride) in powder form.

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**VITRIC-10**—United States Stoneware Co., Akron, O. Ceramic base, nonplastic; furnished in powder form for casting into parts, or as complete parts; corrosion and heat resistant (1000 degrees Fahr.); nonflammable; compressive strength 3500 lbs. per sq. in.; dielectric strength 40 volts per mil; available in colors. Used for cementing and sealing.

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**VULCABESTON**—Colt's Patent Fire Arms Mfg. Co., Hartford, Conn. Hard rubber, or Neoprene and asbestos base, thermosetting; furnished in sheet and laminated forms or rods and tubes for machining into parts or supplied as complete parts; heat resistance 750 degrees Fahr.; tensile strength 7000 lbs. per sq. in.; dielectric strength 40 volts per mil; corrosion resistant; low moisture absorption. Uses include insulation, brake linings, valve disks, gaskets, packings, etc.

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**VULCOID** — Continental-Diamond Fibre Co., Newark, Del. Resinous base, thermoplastic; furnished in sheets and laminated forms or rods and tubes for machining, stamping or forming into parts; low moisture absorption; dielectric strength 400 volts per mil; tensile strength 11,000 lbs. per sq. in.; resistant to abrasion; flexible in some forms; heat resistant 275 degrees Fahr.; available in red, gray, black; nonflammable; shatterproof. Used for electrical insulation where arc resistance is important. For mechanical insulation where moderate moisture resistance is important.

## W

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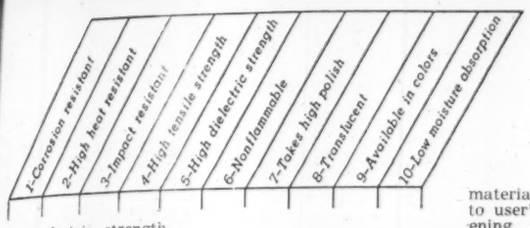
**WELDBORD**—United States Plywood Corp., New York. Urea formaldehyde resin-bonded plywood; thermosetting; available in all woods; shatterproof; high tensile strength and di-




electric strength.

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**WELDWOOD**—United States Plywood Corp., New York. Phenol-formaldehyde resin-bonded plywood; thermosetting; flexibility varies with thickness; obtainable in all woods; shatterproof.

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**WESTFELT**—Western Felt Works, Chicago. Felt material; furnished in cut shapes according to user's specifications; for vibration dampening, deadening sound, insulating against heat and cold and filtering liquids, air and gases; also furnished as oil or dust seals for bearings.

*See advertisement, Page 87-D*

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**WESTFELTOPAK**—Western Felt Works, Chicago. Gasketing material made of high grade resilient felt, coated all sides with synthetic rubber, resistant to many mineral oils, gasoline, petroleum hydrocarbons, chlorinated solvents, alcohols and dilute acids and alkalis. Recommended maximum temperature 175 degrees Fahr.

*See advertisement, Page 87-D*

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**WILMINGTON FIBRE**—Wilmington Fibre Specialty Co., Wilmington, Del. Cotton rag and paper, chemically treated, nonplastic material; furnished in sheet form or rods and tubes for machining or stamping into parts; dielectric strength 200-400 volts per mil; tensile strength 12,000-15,000 lbs. per sq. in.; resistant to shock and corrosion; high polish; available in colors. Used for electrical and mechanical insulation.

# Alphabetical Listing of Producers of Design Materials

## Section I—Iron, Steel and Nonferrous Metals

### A

**Acme Steel Co., 2840 Archer Ave., Chicago.**
Colored strip steel—ACME COLORSTRIP

**Wood, Alan, Steel Co., Conshohocken, Pa.**
High strength steel—"AW" DYN-EL
Rolled steel floor plate—"AW"
High strength steel—DYN-EL

**Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh.**
Stainless steels—ALLEGHENY METAL
Special alloy tool steels—ATLAS No. 93, PYTHON, SEMINOLE, TETON
Nondeforming tool steel—DEWARD
Carbon tool steel—POMPTON
Abrasion resistant alloys—DRAGON, TIOGA
Electrical steels — ALLEGHENY-LUDLUM, MUMETAL and OHMALOY
Mild and stainless steel—PLURAMELT

**Allied Process Corp., 444 Madison Ave., New York.**
Brass base alloy—AETERNA 600 METAL

**Alloy Cast Steel Co., Marion, O.**
Cast alloy steels—CAST ALLOY STEELS

**Aluminum Co. of America, 634 Gulf Bldg., Pittsburgh.**
Aluminum alloys—ALCOA
Aluminum casting alloys—LYNITE
Aluminum sheet—ALCLAD

**Aluminum Industries Inc., 2438 Beekman St., Cincinnati.**
Aluminum base alloys—PERMITE

**American Agile Corp., 5806 Hough Ave., Cleveland.**
Welding electrodes—AGILE

**American Brass Co., Waterbury, Conn.**
Copper-aluminum alloy—AVIALITE
Copper, aluminum and nickel alloy — TEMPALOY
Corrosion resistant alloys—AMBRAC, TOBIN BRONZE, ANACONDA, EVERDUR
*See advertisement, Page 17-D—20-D*

**American Crucible Products Co., 13050 Oberlin Ave., Lorain, O.**
Bearing bronze—PROMET

**American Magnesium Corp., 2210 Harvard Ave., Cleveland.**
Magnesium alloy—MAZLO
*See advertisement, Page 69-D*

**American Manganese Steel Div., The American Brake Shoe & Foundry Co., Chicago Heights, Ill.**
Cast alloy steels and welding rods—AMSCO
Welding rod—MO-MANG

**American Nickeloid Co., 23 Second St., Peru, Ill.**
Prefinished bonded sheet and strip—NICKELOID, CHROMALOID, BRASSOID, COPPEROID, AMERICAN BONDED METALS

**American Rolling Mill Co., Middletown, O.**
Stainless and high tensile steels—ARMCO high silicon steel—Pure iron—ARMCO ingot iron
Galvanized sheet iron or steel—ZINCGRIP and PAINTGRIP

**American Smelting & Refining Co., Equitable Bldg., New York.**
Cadmium-nickel bearing alloy—ASARCOLOY NO. 7
Lead bearing alloy—"G" ALLOY

**American Steel Foundries, 410 N. Michigan Ave., Chicago.**
High strength cast steel—HYLASTIC

**American Steel & Wire Co., Rockefeller Bldg., Cleveland.**
Carbon steels and alloys—AMERICAN QUALITY
Cold finished steel bars—AMERCUT

**Ampco Metal Inc., 1745 South 38th St., Milwaukee.**
Corrosion and shock resistant alloys—AMPCO METAL
Coated welding rods—AMPCO-TRODE
Copper base alloys—AMPCOLOY
*See advertisement, Page 71-D*

**Amplex Mfg. Co., Div. of Chrysler Corp., 6500 Harper Ave., Detroit.**
(See Chrysler Corp.)

**Anchor Drawn Steel Co., Latrobe, Pa.**
High carbon steel—RED ANCHOR

**Apollo Metal Works, 66th Place and South Oak Park Ave., Chicago.**
Pre-finished cold-rolled steel—APOLLO CHROMSTEEL

**Apollo Steel Co., Apollo, Pa.**
Copper-bearing steel—APOLLOY METAL

**Aurora Metal Co., 614 West Park Ave., Aurora, Ill.**
Aluminum bronze alloy—AUROMET

### B

**Babcock & Wilcox Co., 85 Liberty St., New York.**
Corrosion and heat resisting alloys—ADAMANTINE, ELVERITE
*See advertisement, Page 65-D*

**Babcock & Wilcox Tube Co., Beaver Falls, Pa.**
Corrosion and heat resisting steel tubes—B & W CROLOY
*See advertisement, Page 65-D*

**Baker & Co. Inc., 113 Astor St., Newark, N. J.**
Platinum alloy—BAKER, PLATINUM-CLAD

**Beckett Bronze Co., Muncie, Ind.**
High lead bronze—BECKETT METAL

**Belle City Malleable Iron Co., Racine, Wis.**
Pearlitic malleable iron—BELMALLOY
High strength malleable iron—BELECTROMAL
Electric furnace melted cast iron—BELECTRIC

**Bethlehem Steel Co., Bethlehem, Pa.**
Corrosion resistant alloy steels—BETHADUR
Copper bearing steel—BETH-CU-LOY
Stainless steel—BETHALON
High carbon, manganese and nickel steels; and chromium-molybdenum steel castings—BETHLEHEM
High temperature alloy steel—SUPERTEMP
Nickel-chromium steels—MAYARI

**Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa.**
Alloy cast steels—BIRDSBORO

**Bishop, J., & Co. Platinum Works, Malvern, Pa.**
Stainless seamless tubing—BISHOP

**Bliss & Laughlin Inc., P. O. Box 945, Buffalo, N. Y.**
High sulphur bessemer screw stock—ULTRACUT

**Bohn Aluminum & Brass Corp., Lafayette Bldg., Detroit.**
Light aluminum alloy—BOHNALITE

**Bound Brook Oil-less Bearing Co., Bound Brook, N. J.**
Bearing bronzes—BOUND BROOK, COMPO
*See advertisement, Page 81-D*

**Bridgeport Brass Co., Bridgeport, Conn.**
High copper silicon bronzes—DURONZE
Copper and zinc alloys—BRIDGEPORT

**Buckeye Brass & Mfg. Co., 6410 Hawthorne, Cleveland.**
Bearing bronzes—COMMERCIAL, HYSPEED, LUBRICO
*See advertisement, Page 25-D*

**Buffalo Foundry & Machine Co., Buffalo.**
Corrosion and heat resistant alloy—BUFLOKAST

**Buffalo Wire Works Co. Inc., Buffalo, N. Y.**
Wire cloth—BUFFALO
*See advertisement, Page 83-D*

**Bunting Brass & Bronze Co., Spencer and Carlton Sts., Toledo, O.**
Bearing bronzes—BUNTING
*See advertisement, Pages 6-D—7-D*

**Burgess-Parr Co., Freeport, Ill.**
Acid resisting alloy—ILLIUM

### C

**Cadman, A. W., Mfg. Co., 2816 Smallman St., Pittsburgh.**
Nickel bronze alloy—NICUITE
Babbitt metal—BEARITE, ACORN
Copper alloy—CUPALOY

**Cannon-Stein Steel Corp., 817 South State St., Syracuse, N. Y.**
Manganese and chromium nickel steels—RITA
Corrosion and heat resistant alloy—CANNON
3½ per cent nickel steel

**Carboloy Co. Inc., 11177 East 8-Mile Rd., Detroit.**
Cemented carbide—CARBOLOY

**Carnegie-Illinois Steel Corp., Carnegie Bldg., Pittsburgh.**
Abrasion resisting alloy—U. S. S. AR STEEL, U. S. S. CARILLOY, U. S. S. COR-TEN, U. S. S. MAN-TEN.

**Carpenter Steel Co., Reading, Pa.**
Carbon, chromium and chromium nickel steels—CARPENTER
*See advertisement, Pages 12-D—13-D*

**Cerro de Pasco Copper Corp., 44 Wall St., New York.**
Bismuth-lead-tin-antimony castings — CERROMATRIX, CERROBASE, CERROBEND

**Chace, W. M., Co., 1614 Beard Ave., Detroit.**
Thermostatic bi-metal — CHACE THERMOSTATIC BI METAL
*See advertisement, Page 83-D*

**Chain Belt Co., 1604 W. Bruce St., Milwaukee.**
High-tensile, corrosion-resistant alloy—REX Z METAL

**Chambersburg Engineering Co., Chambersburg, Pa.**
Nickel-molybdenum iron alloys—CECOLLOY, CECOLLOY IRON

**Chase Brass & Copper Co., Waterbury, Conn.**
Corrosion resistant copper alloys—OLYMPIC BRONZE, ANTIMONIAL ADMIRALTY, CHAMET PRONZE, CHASE 444 BRONZE, CHASE and TELLURIUM COPPER

**Chrysler Corp., Amplex Div., 6500 Harper Ave., Detroit.**
Bearing bronze—OILITE

**Cinaudagraph Corp., Stamford, Conn.**
Nickel-aluminum-iron alloy—NIPERMAG

**Cleveland Twist Drill Co., The, 1242 East 49th St., Cleveland.**
High speed steel—MO-MAX

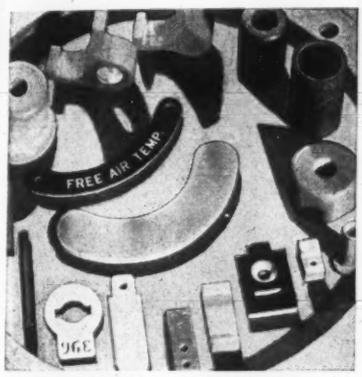
**Climax Molybdenum Co., 500 Fifth Ave., New York.**
Molybdenum steel—MO-LYB-DEN-UM
*See advertisement, Page 77-D*

**Cold Metal Process Co., The, Youngstown, O.**
Carbon and alloy strip steel—CMP STRIP

**Colonial Alloys Co., Colonial Philadelphia Bldg., Philadelphia.**
Corrosion resistant alloy—COLALLOY

# What is FORMICA For?

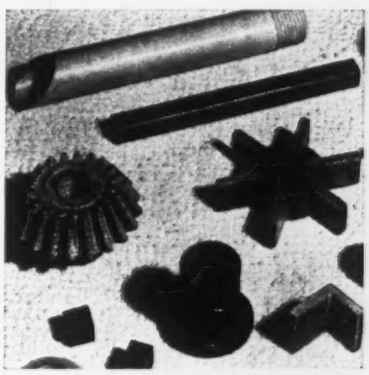
AN unusual combination of qualities makes Formica useful for a great variety of purposes in industry. It has high efficiency as an electrical insulator and therefore has wide applications in electrical manufacturing; it combines light weight with strength and stability of dimensions, qualities that are highly valued in the aviation industry; it is one of the most inert chemically of organic materials, which wins it a place in chemical industries such as rayon manufacture and plating; it is strong mechanically but non-metallic and non-resonant so it is applied to machinery in the form of silent gears; it is handsome, durable, spot-proof and stable in color so that it is used as a surfacing material for table tops, desks and for building purposes.




ELECTRICAL INSULATION

## ELECTRICAL INSULATION

Formica has high insulation resistance, low power factor and low hysteresis losses. It is relatively free from cold flow. Because it resists moisture absorption and has a low coefficient of thermal expansion it maintains its dimensions under a wide range of conditions.



CHEMICALLY RESISTANT PARTS

## CHEMICALLY RESISTANT PARTS

Machined and molded parts of Formica are used in equipment for chemical processes such as plating metal or manufacturing rayon. Special grades emphasize resistance to acids or to alkalies. Parts made from it last much longer than the metal they replace. It is also uninjured by petroleum and its derivities and can be used in pumps, etc., in the oil industry.

PARTS FOR AIRPLANES

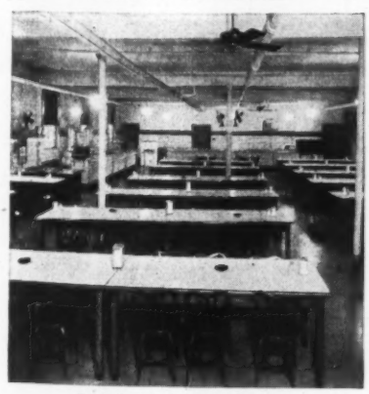
## PARTS FOR AIRPLANES

Formica has half the specific gravity of aluminum; it is strong mechanically and its tendency to maintain its dimensions under sharp changes of humidity and temperature have won it many applications in the airplane industry.

GEARS AND MECHANICAL USES

## GEARS AND MECHANICAL USES

Replacing cast iron gears in drive trains Formica introduces a non-metallic, resilient link in the chain which reduces noise and absorbs shocks. It is unaffected by oil and can be used where chemicals would destroy metal gears.



FACTORY RESTAURANTS

## FACTORY RESTAURANTS

In a very large percentage of the new defense plants Formica table tops are being used in the restaurants, because it is sanitary, durable, good looking and spot proof.

FURNITURE AND BUILDINGS

## FURNITURE AND BUILDING

Desk tops, wainscot, doors, column covering, counters in many public buildings have been surfaced with Formica. It combines permanent good looks, with practical absence of maintenance.

Send for the Formica Data Book which discusses all of these matters in greater detail.

FORMICA

FORMICA

**The Formica Insulation Co., 4673 Spring Grove Ave., Cincinnati, O.**

**Columbia Steel & Shafting Co., Woodkrik St., Pittsburgh, Pa.**
High tensile steel—COLUMBIA

**Continental Roll & Steel Foundry Co., East Chicago, Ind.**
Hard alloys for rolls—DUQUESNE SPECIAL, CROMONITE, HUBBARD SPECIAL, CRASFLOY
Alloy cast steels—DYNAMIC STEEL, TEMP ALLOY, MOLYBDENITE and CONTINENTAL SUPER STEEL

**Cooper Alloy Foundry Co., 150 Broadway, Elizabeth, N. J.**
Corrosion and heat resisting—COOPER ALLOY

**Copperweld Steel Co., Glassport, Pa.**
Bearing alloy—ARISTOLOY

**Cramp Brass & Iron Foundries Div. Baldwin Locomotive Works, Philadelphia.**
Copper alloys—CRAMP ALLOYS

**Crucible Steel Co. of America, 405 Lexington Ave., New York.**
High strength alloy steels—DUPLEX, MAXEL and SIMPLEX
Corrosion and heat resistant alloys—LO CRO and RESISTAL
Forging steel—ALMO

## D

**Delloy Metals, 1812 Russell St., Philadelphia.**
Wear resistant alloy—DELLOY

**Detroit Alloy Steel Co., Ft. of Iron St., Detroit.**
Alloy steel castings—KROKOLOY, CASTALOY, MARTIN STEEL, FLAMALOY
Oil hardening steel castings—CARBOMANG

**Doehler Die Casting Co., 386 Fourth Ave., New York.**
Copper-zinc-silicon alloys — DOLER-BRASS, DOLER-ZINK
Magnesium base alloys—DOLER-MAG
Aluminum base die castings—DOLER-ALUMIN

**Dole Valve Co., The, 1901 Carroll Ave., Chicago.**
Thermostatic bimetal—DOLE

**Dow Chemical Co., Midland, Mich.**
Corrosion resistant light alloys—DOWMETAL
*See advertisement, Page 3-D*

**Driver-Harris Co., Harrison, N. J.**
Corrosion, heat and wear resisting alloys — ADVANCE, NIREX, NILVAR, CHROMAX, CIMET, NICHROME, HYTEMCO, DRIVER-HARRIS 42 and 52 ALLOYS

**Duriron Co. Inc., Dayton, O.** (and licensees—see Duriron in tradename listing).
Corrosion and heat resistant alloys—ALCUMITE, DURICHLOR, DURIMET, DURIRON, DURCO

## E

**Electro Metallurgical Sales Corp., 30 East 42nd St., New York.**
Ferro-alloy—ELECTROMET

**Erie Malleable Iron Co., Erie, Pa.**
Abrasion and wear resisting malleable iron—ERMAL, ERMALITE

## F

**Farrell-Cheek Steel Co., Sandusky, O.**
Abrasion resisting cast steel—FARRELL's 85, FARRELLS's HARD EDGE

**Federal Mogul Corp., 11031 Shoemaker Ave., Detroit.**
Bearing bronzes—FEDERAL
Babbitt bearing alloys—MOGUL
Lead base babbitt—BERMAX BABBITT

**Ferrous Metals Corp., 444 Madison Ave., New York.**
High abrasion resistant alloy—Z-METAL

**Firth-Sterling Steel Co., McKeesport, Pa.**
Carbon tool steels—STERLING
Cemented carbides—FIRTHITE
Sintered carbide—FIRTHALOY
Stainless steels—STERLING-NIROSTA

**Foote Bros. Gear and Machine Corp., 5301 S. Western Blvd., Chicago.**
Nickel-molybdenum alloy—FIVEPOINT DEEP-HARD STEEL

**Frank Foundries Corp., Moline, Ill.**
Corrosion-abrasion resistant alloys—FRANKITE

**Frontier Bronze Corp., 818 Elmwood Ave., Niagara Falls, N. Y.**
Heat-resisting alloys—FRONTIER
Titanium-copper alloy—TI-COPPER NO. 39

## G

**General Alloys Co., 367-405 W. First St., Boston.**
Corrosion, heat and wear resisting alloy castings—X-ITE, X-7, Q-ALLOYS, ECONOMET

**General Electric Co., Schenectady, N. Y.** (and licensees—see Alnico in tradename listing).
Magnet alloy—ALNICO
Welding electrode—TRODALOY NO. 1

**General Plate Div., Metals & Controls Corp., Attleboro, Mass.**
Thermostatic metals—TRUFLEX

**Gibson Electric Co., 585 Blvd. of the Allies, Pittsburgh.**
High ductility alloy—GIBSILOY

**Globe Steel Tubes Co., Milwaukee.**
Seamless steel tubing—GLOBE

**Great Lakes Steel Corp., Div. of National Steel Corp., Ecorse, Detroit, Mich.**
Impact-resistant alloy—DUCTILOY
High tensile alloy—N-A-X

## H

**Handy & Harman, 82 Fulton St., New York.**
Brazing alloys — HANDY FLUX, SILFOS, EASY-FLO

**Hardy Inc., Charles, 415 Lexington Ave., New York.**
Powdered metal—HARDY POWDERS

**Haynes Stellite Co., 205 E. 42nd St., New York.**
Heat, corrosion and wear-resistant alloys—HAYNES STELLITE
Abrasion-resistant alloy — HAYNES STELLITE "93", HAYSTELLITE
Impact-resistant hard-facing rod — HASCROME
Corrosion resistant alloys—HASTELLOY

**Heppenstall Co., Hatfield St., Pittsburgh.**
Abrasion resistant alloy steels — HARDTEM, KLEENKUT
High strength alloy steel—HEPPENSTALL, HEPPENSTALL 5H50, EIS45
Nickel chrome molybdenum steel—EIS-57

**Hoskins Mfg. Co., 4445 Lawton Ave., Detroit.**
Heating element alloys—CHROMEL

## I

**Industrial Steels Inc., East Cambridge, Mass.**
Stainless steels and irons — INDUSTRIAL, Nos. 35 and 12, respectively.

**Ingersoll Steel & Disc Division, Borg-Warner Corp., 310 S. Michigan Ave., Chicago.**
Stainless clad steel—INGACLAD
Stainless steel—INGERSOLL

**Inland Steel Co., 38 S. Dearborn St., Chicago.**
High strength, corrosion resistant and copper bearing steels and spring steel—INLAND
Abrasion resisting steel—LEDLOY STEELS 10

**International Nickel Co. Inc., 67 Wall St., New York** (and licensees).
Corrosion, heat and wear resisting alloys—NI-TENSYLIRON, NI-HARD, NI-RESIST, NICKEL, MONEL, INCONEL
*See advertisement Page 63-D*

## J

**Jeffrey Mfg. Co., The, First Ave. and Big Four railroad, Columbus, O.**
High strength malleable irons — PERDURO, SUPERMAL

**Jessop Steel Co., Washington, Pa.**
Nonmagnetic and stainless steels—JESSOP
Stainless clad steel—SILVER-PLY
Stainless steels—DURO-GLOSS, HI-GLOSS and STA-GLOSS

**Johnson Bronze Co., New Castle, Pa.**
Bearing metals — JOHNSON, LEDALOYL, JSB
*See advertisement, Page 20-D*

**Jones & Laughlin Steel Corp., Jones & Laughlin Bldg., Pittsburgh.**
Free machining steel—JALCASE
Forging steel—J & L CORRECT BALANCE

## K, L

**Keystone Carbon Co., Saint Marys, Pa.**
Self-lubricating porous bronze—SELFLUBE
*See advertisement Page 79-D*

**Koppers Co., Bartlett-Hayward Div., Baltimore.**
Bronze alloy—D-H-S BRONZE.

**Lake City Malleable Co., 5060 Lakeside Ave., Cleveland.**
Malleable iron—SHOCK PROOF

**La Salle Steel Co., 150th and Magnolia, Hammond, Ind.**
High-tensile alloy—STRESSPROOF

**Lebanon Steel Foundry, Lebanon, Pa.**
Alloy cast steels—CIRCLE L

**Lehigh Babbitt Co., Box 504, Allentown, Pa.**
Graphited babbitt metals—GRAPHO

**Lincoln Electric Co., 12818 Coit Rd., Cleveland.**
High tensile welding rods — SHIELDARC, LIGHTWELD, MANGANWELD, WEARWELD, HARDWELD, ABRASOWELD, TOOLWELD, AERISWELD, FLEETWELD, STAINWELD, CHROMEWELD, FERROWELD, SOFTWELD, ALUMINWELD, READYWELD, SURFACEWELD, NICKELCHROMEWELD, PLANEWELD, TRANSWELD, FACEWELD

**Linde Air Products Co., The, 205 42nd St., New York.**
Welding rods—OXWELD
*See advertisement, Page -5D*

**Link-Belt Co., 220 S. Belmont Ave., Indianapolis.**
Malleable cast iron—PROMAL

**Lukens Steel Co., Coatesville, Pa.**
Various types of steels—LUKENS

**Lumen Bearing Co., 207 Lathrop Ave., Buffalo.**
Wear resisting—MACHINEBRONZE
High tin babbitt—STANNUM BABBITT
Lead base bearing babbitt—LOTUS BABBITT
Bearing alloys—LUMEN ALLOYS

## M

**Magnolia Metal Co., 120 Bayway, Elizabeth, N. J.**
Babbitt metal—ADAMANT SUPER-GENUINE BABBITT
Bearing bronze—MAGNOLIA and MAGNOLIA Antifriction Metal

**Mallory, P. R., & Co. Inc., Indianapolis.**
Welding electrodes—ELKALOY
Wear resistant alloy—ELKONITE
Copper base alloys—MALLORY and ELKON BRONZE

**Manganese Steel Forge Co., Allen St. and Butler Ave., Philadelphia.**
Forged alloy steel—ROL-MAN

**Massillon Steel Casting Co., Massillon, O.**
Alloy cast steel—MASSILLON, TIGERLOY
Nitriding steel—NITRALLOY

**Maurath Inc., 7301 Union Ave., Cleveland.**
Welding rod—MAURATH

**McGill Mfg. Co., Valparaiso, Ind.**
Corrosion resistant alloys—McGILL

**McKenna Metals Co., 1 Lloyd Ave., Latrobe, Pa.**
Carbide alloys—KENNAMETAL
*See advertisement, Page 79-D*

**Meehanite Metal Corp., 311 Ross St., Pittsburgh** (and licensees—see Meehanite in tradename listing).
Wear, heat and corrosion resistant alloys—MEEHANITE
*See advertisement, Page 93-D*

**Metal Carbides Corp., Youngstown, O.**
Tungsten carbide metal—TALIDE

**Metal & Thermit Corp., 120 Broadway, New York.**
Welding electrodes—MUREX

**Metals Disintegrating Co. Inc., Elizabeth, N. J.**
Powder metal—METALS DISINTEGRATING
*See advertisement, Page 15-D*

**Metals Refining Co., Hammond, Ind.**
Powder metal—MRCO METAL POWDER

**Molybdenum Corp. of America, Grant Bldg., Pittsburgh.**
Molybdenum steel—MCA MOLYBDENUM

**Moraine Products Div., General Motors Corp., 1540 Wisconsin Blvd., Dayton, O.**
Bearing alloys—DUREX, MORAINE
Powder Metal—POREX
*See advertisement, Page 26-D*

**Morganite Brush Co. Inc., 3302 48th Ave., Long Island City, N. Y.**
Carbon-graphite-metal—MORGANITE
*See advertisement Page 75-D*

## N

**National Alloy Steel Division, Blawnox, Pa.**
Corrosion resisting castings—NA, NA-1, NA-2

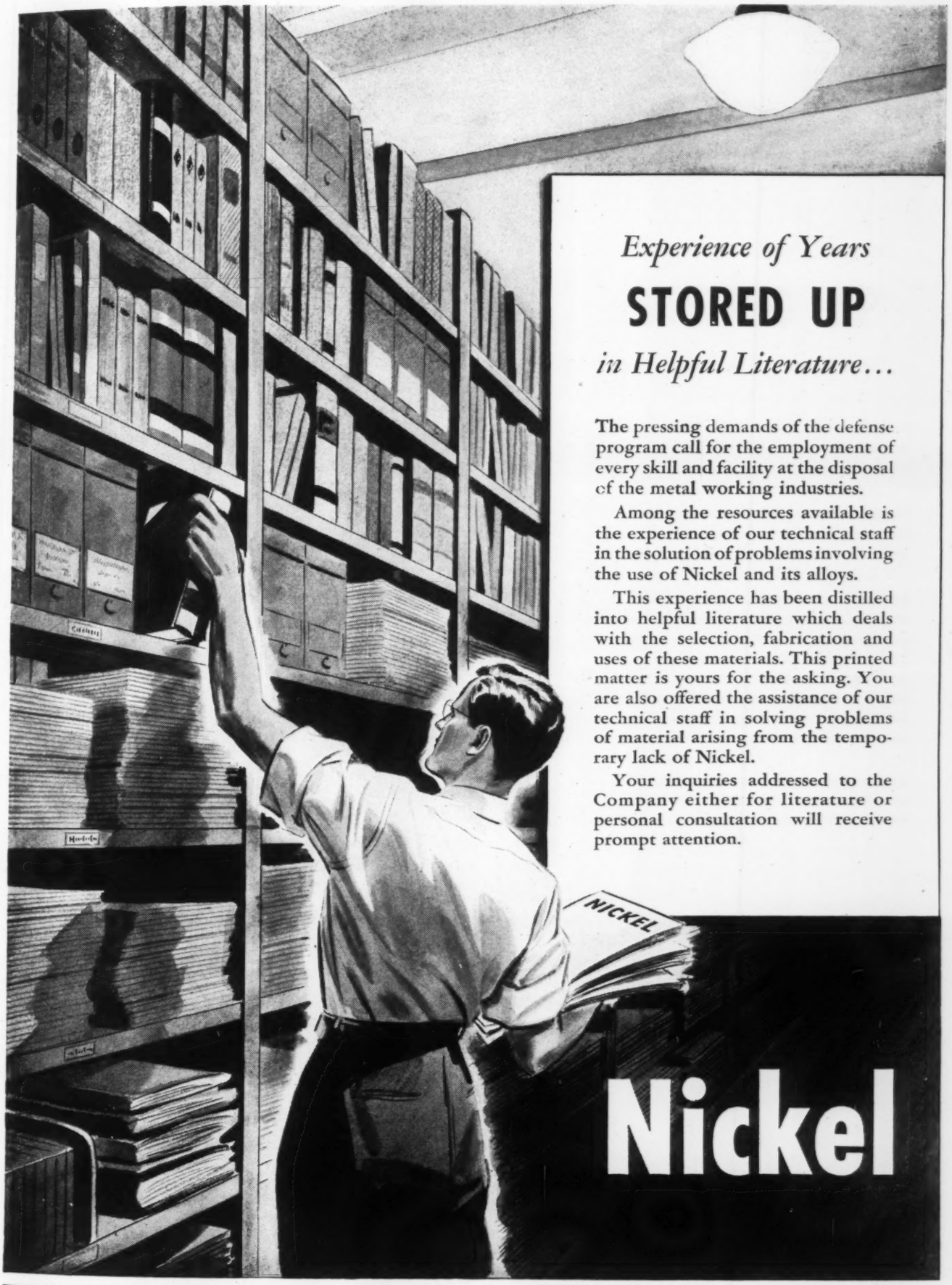
**National Bronze & Aluminum Foundry Co., East 88th and Laisy Ave., Cleveland.**
Aluminum alloy—T-1

**National Erie Corp., Erie, Pa.**
Steel castings—NELOY

**National Lead Co., 111 Broadway, New York.**
Babbitt metal for bearings—DUTCH BOY BABBITT, HOYT BABBITT METAL

**National Malleable & Steel Castings Co., 10600 Quincy Ave., Cleveland.**
Alloy cast steel—NACO
Malleable cast iron—MALLIX
Chromium-manganese-carbon alloy—NUREX
High strength steel—NATIONAL NO. 6

**New Jersey Zinc Co., 160 Front St., New York.**
Zinc alloy—ZAMAK, ZILLOY




*Experience of Years*

# STORED UP

*in Helpful Literature...*

The pressing demands of the defense program call for the employment of every skill and facility at the disposal of the metal working industries.

Among the resources available is the experience of our technical staff in the solution of problems involving the use of Nickel and its alloys.

This experience has been distilled into helpful literature which deals with the selection, fabrication and uses of these materials. This printed matter is yours for the asking. You are also offered the assistance of our technical staff in solving problems of material arising from the temporary lack of Nickel.

Your inquiries addressed to the Company either for literature or personal consultation will receive prompt attention.

**Nickel**

**THE INTERNATIONAL NICKEL COMPANY, INC.** 67 WALL STREET NEW YORK, N. Y.

Nitralloy Corp., The, 230 Park Ave., New York (licensees—see Nitralloy in tradename listing).
Nitriding steel—NITRALLOY
*See advertisement, Page 11-D*

## P

**Phelps Dodge Copper Products Corp., 40 Wall St., New York.**
High tensile silicon bronze—PMG METAL
Copper alloy—PDCP COPPER
Copper-zinc-tin alloys — BLACKSKIN ADMIRALTY, ADMIRALTY METAL, SUPERLOY
Arsenical copper—BULLDOG BRAND
Aluminum brass—BULLDOG BRAND
Copper Nickel—BULLDOG BRAND

**Pittsburgh Steel Co., Grant Bldg., Pittsburgh.**
Stainless steels—PITTSBURGH STAINLESS

**Horace T. Potts Co., E. Erie Ave. and D St., Philadelphia.**
Chromium - molybdenum alloy — ELASTUF, CHRO-MOLY
Chromium-vanadium alloy—ELASTUF TYPE A
Chrome-nickel-molybdenum alloy — ELASTUF "44"
Carbon-manganese-silicon abrasion resisting steel—WEARTUF
Manganese type steel—ELASTUF PENN, STRAINFREE ELASTUF PENN
Free-machining case hardening steel—ELASTUF C. H.

**Precision Castings Co. Inc., Syracuse, New York.**
Aluminum and zinc base alloys—PRECISION

## R

**Randall Graphite Products Corp., 609 W. Lake St., Chicago.**
Graphite bronze bearings and bushings—RANDALL
*See advertisement, Page 87-D*

**Republic Steel Corp., Republic Bldg., Cleveland.**
Open hearth iron alloy—TONCAN IRON
Stainless and heat resisting alloys—ENDURO
High strength alloy—REPUBLIC
Low-alloy, copper-nickel-molybdenum steel—REPUBLIC DOUBLE STRENGTH
Enameling stock—TONCAN IRON
Copper-bearing steel—U-LOY

**Revere Copper & Brass Inc., 230 Park Ave., New York.**
Nonmagnetic, corrosion resistant, silicon bronze—HERCULOY
Bearing bronze—ROMAN BRONZE
Condenser tubes and plates, REVALON and REVERE CUPRO-NICKEL, 30 per cent

**Rhoades, R. W., Metaline Co., Inc., P. O. Box No. 1, Long Island City, N. Y.**
Heat resisting bearing bronze—METALINE

**Riverside Metal Co., Riverside, N. J.**
Copper-tin-nickel-zinc alloy—RIVERSIDE

**Rustless Iron & Steel Corp., 3400 E. Chase St., Baltimore.**
Chromium and chromium nickel stainless steels — DEFIRUST, DEFIHEAT, DEFISTAIN, RUSTLESS and RUSTLESS 17
Hardening type stainless steel—RUSTLESS

**Ryerson, Jos. T., & Son Inc., 16th and Rockwell Sts., Chicago.**
Specially processed lead base alloys—GLYCO BABBITT

## S

**Saginaw Bearing Co., Saginaw, Mich.**
Bearing bronzes—SABECO and AGRICOLA
*See advertisement, Page 2-D*

**Sandusky Foundry & Machine Co., Sandusky, O.**
Nickel-chromium and molybdenum cast iron alloys—SANDUSKY ALLOY IRON
Bronze, brass and manganese bronze alloys—SANDUSKY BRONZES

**Scomet Engineering Co., Carteret, N. J.**
Oxygen-free copper—OFHC

**Scovill Mfg. Co., Waterbury, Conn.**
Copper alloys—ADNIC
Hardware bronze—SCOVILL
Spring material—OREIDE
Copper-lead-zinc alloy—SCOVILL FREE-CUTTING BRASS ROD
Copper-tin-zinc alloy — SCOVILL NAVAL BRASS
Copper tubing—SCOVILL Phosphorized Admiralty Metal

**Seitzinger's, T. F., & Sons, 900 Ashby, N. W., Atlanta, Ga.**
Bearing bronze—DIXOILBRONZ

**Sharon Steel Co., Sharon, Penna.**
Stainless and heat resisting alloy—SHARON

**Shenango-Penn Mold Co., Dover, O.**
High strength alloys—SHENANGO-PENN

**Sivyer Steel Casting Co., 1675 S. 43rd St., Milwaukee.**
Corrosion and heat resisting cast steels—SIVYER
Abrasion resisting cast steel—SIVYER
Alloy cast steels—SIVYER

**Standard Alloy Co., 1679 Collamer Ave., Cleveland.**
Corrosion and heat resisting alloys—STANDARD-ALLOY

**Steel & Tubes Division, Republic Steel Corp., Cleveland.**
Copper bearing tubing—ELECTRUNITE

**Stoody Co., Whittier, Calif.**
Wear resisting alloys—STOODITE, STOODITE (Numbered), STOODY (Self-Hardening), SILFRAM, BORIUM

**Sumet Corp., 1543 Filmore Ave., Buffalo.**
Bronze bearings—SUMET

**Summerill Tubing Co., Bridgeport, Montgomery Co., Pa.**
Seamless tubing—SUMMERILL

**Superior Steel Corp., Carnegie, Pa.**
Stainless strip steel—SUPERIOR STAINLESS

## T

**Taylor-Wharton Iron & Steel Co., High Bridge, N. J.**
Corrosion and abrasion resistant alloys—TISCO
Austenitic wear resisting steel—TIMANG

**Thomas Steel Co., Warren, O.**
Cold rolled strip steel—THOMASTRIP

**Timken Steel & Tube Div., The Timken Roller Bearing Co., Canton, O.**
Abrasion resistant bearing alloys—GRAPHTUNG, GRAPH-SIL, GRAPH-MO
Creep resisting alloy steels—DM STEEL, DM-45, SICROMO STEEL
Heat resistant alloys—SILMO, TIMKEN 17-22A

**Titanium Alloy Mfg. Co., Niagara Falls, N. Y.**
Extra low carbon trimming steel—TAMCO

**True Alloys Inc., 1820 Clay St., Detroit.**
Aluminum-bronze alloys—TRUALOY

## U

**Union Drawn Steel Div., Republic Steel Corp., Massillon, O.**
Cold drawn steels—UNION

**Union Steel Casting Division, 62nd and Butler Sts., Pittsburgh.**
Nickel-vanadium steel—UNIVAN

**Unitcast Corp., Steel Casting Div., Toledo, O.**
Cast steels—TOLEDO ALLOY
*See advertisement, Page 94-D*

**United States Graphite Co., Saginaw, Mich.**
Bearing bronze—GRAMIX
Graphitic carbon—GRAPHITIC CARBON

**United States Steel Corp., 434 Fifth Ave., Pittsburgh. (See Carnegie-Illinois Steel Corp.)**
Stainless steels, Shelby tubing, castings, and electrical steel sheets—USS
Atmospheric corrosion and abrasion resistant alloys—U.S.S. COR-TEN, and U.S.S. MAN-TEN

## W

**Wall-Colmonoy Corp., Buhl Bldg., Detroit.**
Cast welding rods—COLMONOY

**Waukesha Foundry Co., North Chicago, Ill.**
Copper-base alloy—WAUKESHA

**Wellman Bronze & Aluminum Co., 6017 Superior Ave., Cleveland.**
Copper-tin-zinc-lead alloys—IDEALOY, ANFRILOY
Aluminum-silicon-titanium alloy—WELLCAST 17S

**West Steel Casting Co., 805 E. 70th St., Cleveland.**
Molybdenum-vanadium-nickel alloy—CUMLOY
High tensile strength alloy—DURACAST

**Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.**
Corrosion and heat resisting alloy—KONAL, PHOS-COPPER, K-42-B
Magnetic alloy—HIPERNIK
Gas type metal—KOVAR
Copper base alloy—CUPALOY
Iron-cobalt-alloy—CUFERCO

**Wheelock, Lovejoy & Co. Inc., 128 Sidney St., Cambridge, Mass.**
Machinery steels—ECONOMO, HYTEN

**Wilcox-Rich Div., Eaton Mfg. Co., 9771 French Rd., Detroit.**
Corrosion and abrasion resistant alloys—WILRICH, XALOY

**Williams, E. A., & Son Inc., 111 Plymouth St., Jersey City, N. J.**
Babbitt metals for bearings—CLOVERLEAF BABBITT, DIAMOND G BRONZE, MILL BRASS MIX
Bearing bronzes—WILLIAMS No. 50 ALUMINUM BRONZE

**Wilson, H. A., Co., 105 Chestnut St., Newark, N. J.**
Thermostatic bimetal — WILCO THERMOMETAL, WILCO Contact Materials
*See advertisement, Page 85-D*

**Wolverine Tube Co., 1411 Central Ave., Detroit, Detroit.**
Tubing—WOLVERINE

**Worthington Pump & Machinery Corp., Harrison, N. J.**
Corrosion and abrasion resistant alloy—WORTHITE

## Y

**Youngstown Alloy Casting Corp., Youngstown, O.**
High tensile strength—TRANTINYL

**Youngstown Sheet & Tube Co., Youngstown, O.**
High strength alloy steel—YOLOY

# Section II—Plastics and other Nonmetallics

## A

**American Cyanamid Co., Beetleware Div., 30 Rockefeller Plaza, New York.**
Urea formaldehyde plastic—BEETLE

**American Felt Co., 315 Fourth Ave., New York.**
Felt material—"K" FELT
*See advertisement, Page 85-D*

**American Hard Rubber Co., 11 Mercer St., New York.**
Hard rubber—ACE

**American Phenolic Corp., 1250 W. Van Buren St., Chicago.**
Phenolic plastic—AMPHENOL

**American Plastics Corp., 225 W. 34th St., New York.**
Casein plastic—AMEROID

**American Products Mfg. Co., Oleander and Dublin Sts., New Orleans.**
Cellulose derivative—INCELOID

**American Wringer Co., Woonsocket, R. I.**
Synthetic rubber—TENSILASTIC
*See advertisement, Page 75-D*

**Am-mex Sales Co. Inc., 28 Church St., Buffalo.**
Plastic bonded plywood — SWEET HOME BRAND

**Armstrong Cork Co., Lancaster, Pa.**
Cork-and-synthetic-rubber—CORPRENE
Resilient board of cork granules—VIBRACORK
*See advertisement, Page 89-D*

**Atlas Powder Co., Zapan-Keratol Div., Stamford, Conn.**
Cloth base and Bakelite resinous plastic—REVOLITE

This sketch of the B&W piercing operation shows how the hot tube round is driven against and over the piercing point, forcing the semi-plastic metal outward. Such rigorous treatment not only magnifies any flaws in the billet, but subjects the steel to a forging action which refines the grain structure, thus testing and at the same time improving the steel.

# The Inside Story

Hollow machine parts produced from seamless steel tubing are less likely to reveal flaws on final inspection. Why? Because the seamless piercing operation *demands* the cleanest, most homogenous steel commercially obtainable.

In this respect parts machined from B&W tubing are most dependable of all. Why? Because the B&W piercing mills employ a unique adaptation of the conventional Mannesman piercing process which causes less distortion in piercing.

If you have had a problem of seams opening up during machining, investigate B&W tubing. The solution may be as simple as that.

B&W Seamless Steel Mechanical tubing available in carbon grades and all SAE alloys both in Hot Finished and Cold Drawn quality. Also in many free-machining or carburizing grades such as X-1020-90, X-1315, X-1335, 1120, etc.

TA-1172

**BABCOCK & WILCOX TUBES**

HOT FINISHED COLD DRAWN ALLOY STEELS CARBON STEEL

THE BABCOCK & WILCOX TUBE COMPANY, BEAVER FALLS, PA.

## B

**Bakelite Corp., 30 E. 42nd St., New York.**
Phenolic plastics—BAKELITE

**Booth Felt Co., 444—19th St., Brooklyn, N. Y.**
Wool base felt—BOOTH FELT
*See advertisement, Page 81-D*

**Bound Brook Oil-less Bearing Co., Bound Brook, N. J.**
Material for impregnated wood bushings, etc. —NIGRUM
*See advertisement, Page 81-D*

**Brandywine Fibre Product Co., 1404 Walnut St., Wilmington, Del.**
Chemically-treated paper — BRANDYWINE FIBRE

## C

**Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York.**
Resinous plastic—VINYLITE

**Catalin Corp., 1 Park Ave., New York.**
Phenolic plastics—CATALIN, PRYSTAL and CATABOND

**Celluloid Corp., 180 Madison Ave., New York.**
Cellulose acetate plastic—LUMARITH
Cellulose nitrate plastic—CELLULOID
Cellulose acetate (transparent) sheet—LUMARITH, PROTECTOID

**Chicago Rawhide Mfg. Co., 1301 Elston Ave., Chicago.**
Synthetic rubber compounds—SIRVENE
Heat resisting leather—SIRVIS

**Colt's Patent Fire Arms Mfg. Co., 17 Van Dyke Ave., Hartford, Conn.**
Hard rubber and asbestos base material—VULCABESTON

**Continental-Diamond Fibre Co., Newark, Del.**
Phenolic plastic—DILECTO, CELORON
Resinous plastic—VULCOID
Vulcanized fibre—DIAMOND
Flexible material—MICABOND
Resinous plastic—DILECTENE

**Corning Glass Works, Corning, N. Y.**
Ceramic base glass—PYREX

**Cutler-Hammer Inc., 12th and St. Paul, Milwaukee.**
Bituminous plastic—THERMOPLAX
Asbestos base material—PYROPLAX

## D

**Dow Chemical Co., Midland, Mich.**
Plastic granules—ETHOCEL
Thermoplastic—STYRON
Fibrous thermoplastic—SARAN
*See advertisement, Page 3-D*

**Du Pont de Nemours, E. I., & Co. Inc., Wilmington, Del.**
Chloroprene rubber—NEOPRENE
Plastic coated wire mesh—CEL-O-GLASS
Nitrocellulose base—PYRALIN
Polymethyl-methacrylate base—LUCITE
Cellulose acetate base—PLASTACELE
Polyvinyl alcohol—PVA
Thermoplastic—NYLON

**Durez Plastics & Chemicals Inc., North Tonawanda, N. Y.**
Phenolic plastic—DUREZ
*See advertisement, Page 79-D*

**Durite Plastics Inc., 5000 Summerdale Ave., Philadelphia.**
Phenol-furfural plastic—DURITE

## F

**Farley & Loetscher Mfg. Co., Dubuque, Iowa.**
Phenolic and urea plastic—FARLITE
Fibrous core with laminated Bakelite surface —FARLOEX

**Felters Co. Inc., 210 South St., Boston.**
Laminated felt—DUFELT
Felt for vibration isolation, etc.—UNISORB
Felt for grease & oil retention — FELTERS CERTIFIED FELT
*See advertisement, Page 4-D*

**Formica Insulation Co., 4613 Spring Grove Ave., Cincinnati, O.**
Laminated resinous plastic—FORMICA
*See advertisement, Page 61-D*

**Franklin Fibre-Lamitex Corp., 190 E. Twelfth St., Wilmington, Del.**
Phenolic base, thermosetting material—LAMITEX
Hard vulcanized fiber—FRANKLIN

## G

**Garfield Mfg. Co., Garfield, N. J.**
Thermosetting materials—GUMMON (black); HEMIT (gray-white); TEGIT and GARIT

**General Electric Co., 1 Plastics Ave., Pittsfield, Mass.**
Nonrefractory and refractory materials—TEXTOLITE: Two types
Ceramic base—MYCALEX
*See advertisement, Page 67-D*

**Goodrich, B. F., Co., Akron, O.**
Thermoplastic—KOROSEAL

## H

**Haskelite Mfg. Corp., 202 Washington St., Chicago.**
Plastic-bonded plywood—HASKELITE, PLYMETL

**Heresite & Chemical Co., Manitowoc, Wis.**
Phenolic resin—HERESITE

**Hydrocarbon Chemical & Rubber Co., Akron, O.**
Synthetic rubber—HYCAR

## I

**Inceloid Co. Inc., 410 Camp St., New Orleans, La.**
Cellulose derivative—INCELOID

**Irvington Varnish & Insulator Co., Irvington, N. J.**
Thermoplastic—IRV-O-LITE
Varnished tubing—IRV-O-VOLT
Varnished Fiberglas—IRVINGTON
Synthetic resin varnish—HARVEL

## J

**Johns-Manville, 22 E. 40th St., New York.**
Diatomaceous silica material—CELITE
Rubbery, asphaltic-asbestos material — AERITITE
Asbestos, fiber, graphite and rubber compound —EEL-SLIP
Weatherproof coating—INSULKOTE
Fireproof material—TRANSITE
Refractory material—FIRECRETE

## K

**Keasbey & Mattison Co., Ambler, Pa.**
Asbestos materials—HY-TEMP, FEATHERWEIGHT

**Knight, Maurice A., Kelly Ave., Akron, O.**
Depolymerized colloidal resin plastic—PYROFLEX
Corrosion resistant stoneware — KNIGHTWARE

**Korfund Co. Inc., 48-15 — 32nd Place, Long Island City, N. Y.**
Finely granulated compressed cork plates—KOMPO-KORK
Resilient mat of pure natural cork—KORFUND
Finely granulated cork and rubber—KORK RUBBER
Permanent elastic cork material — VIBROPLATE

## L

**Lord Mfg. Co., Erie, Pa.**
Rubber bonding—LORD
*See advertisement, Page 21-D*

**Luzerne Rubber Co., Dewey St., Trenton, N. J.**
Hard rubber, thermoplastic—LUZERNE HARD RUBBER

## M

**Makalot Corp., 262 Washington St., Boston.**
Synthetic resin plastic—MAKALOT

**Marblette Corp., 3721 30th St., Long Island City, N. Y.**
Phenolic plastic—MARBLETTE

**Monsanto Chemical Co., Plastics Div., Springfield, Mass.**
Cellulose nitrate plastic—NITRON
Cellulose acetate—FIBESTOS
Phenolic plastic—OPALON and RESINOX
Polyvinyl acetal plastic—SAFLEX

## N

**National Carbon Co. Inc., Madison Ave. & W. 117th St., Cleveland.**
Carbon or graphite in amorphous or graphitic form—NATIONAL CARBON

**National Vulcanized Fibre Co., Wilmington, Del.**
Laminated Bakelite—PHENOLITE
Cotton cellulose base, vulcanized fiber—NATIONAL FIBRE, NATIONAL SWITCH INSULATION
Cotton rag base, fish paper insulation—PEERLESS
*See advertisement, Page 83-D*

## O, P

**Owens-Corning Fiberglas Corp., Toledo, O.**
Glass, in fibrous form—FIBERGLAS

**Panelyte Div., St. Regis Paper Co., 230 Park Ave., New York.**
Synthetic laminated resinous material — PANELYTE

**Plaskon Co. Inc., 2112 Sylvan Ave., Toledo, O.**
Urea formaldehyde plastic — PLASKON, UNYTE

**Plylock Corp., subsidiary of M & M Wood Working Co., Portland, Ore.**
Phenol-formaldehyde bonded plywood—RESN-PREST

**Polaroid Corp., Cambridge, Mass.**
Light-polarizing glass—POLAROID

## R

**Reilly Tar & Chemical Corp., Merchants Bank Bldg., Indianapolis**
Phenolic plastic—INDUR, INDUR VARNISH

**Resinous Products & Chemical Co., 222 West Washington Sq., Philadelphia.**
Plastic bonded plywoods—AMBERLITE, TEGO and UFORMITE

**Richardson Co., The, Melrose Park, Ill.**
Thermosetting, thermoplastic and translucent plastics—INSUROK
Hard rubber—RUB-TEX, RUB-EROK
Acid-resisting bituminous plastic—EEROK
Sheet (plate) mica—MICAROK
*See advertisement, Page 24-D*

**Rohm & Haas Co. Inc., 222 W. Washington Sq., Philadelphia.**
Acrylic base plastic—PLEXIGLAS, CRYSTALLITE

**Ryerson & Son Inc., Jos. T., 16th and Rockwell Sts., Chicago.**
Bearing material—RYERTEX

## S

**Self-Vulcanizing Rubber Co. Inc., 605 W. Washington Blvd., Chicago.**
Gum rubber base material, in liquid form —AIRVULC
Cold curing gum rubber, liquid form—SELFVULC

**Spaulding Fibre Co. Inc., Tonawanda, N. Y.**
Fibrous material — SPAULDING FIBRE, SPAULDING ARMITE, SPAULDO
Phenolic plastic—SPAULDITE

**Synthane Corp., Oaks, Pa.**
Laminated Bakelite—SYNTHANE
*See advertisement Pages 73-D—74-D*

## T, U

**Taylor Fibre Co., Norristown, Pa.**
Phenolic base thermosetting material—TAYLOR FIBRE

**Tennessee Eastman Corp., Kingsport, Tenn.**
Cellulose ester plastics—TENITE

**Thiokol Corp., Trenton, N. J.**
Synthetic rubber—THIOKOL

**United States Plywood Corp., 46th St. and 12th Ave., New York.**
Resin-bonded plywoods — WELDBORD and WELDWOOD

**United States Stoneware Co., Akron, O.**
Ceramic base, nonplastic—VITRIC-10
Resinous thermoplastics—RESILON, TYGON

## V

**Victor Mfg. & Gasket Co., 5750 Roosevelt Rd., Chicago.**
Compressed sheet packing—VICTOPAC
Vegetable fiber base sheet packing—VICTORITE
Asbestos sheet—VICTOR
Cork sheet—VICTOR
Mineral base asbestos—ASBESTOPRENE
Compounded synthetic rubber—VICTROPRENE

## W

**Western Felt Works, 4117 Ogden St., Chicago.**
Felt material — WESTFELT, GASKOFELT, WESTFELTOPAK and RESISTOFELT
Synthetic rubber—ACADIA
*See advertisement, Page 87-D*

**Westinghouse Electric & Mfg. Co., Trafford, Pa.**
Phenolic plastic—MICARTA

**Wilmington Fibre Specialty Co., Wilmington, Del.**
Paper base material—FYBEROID
Cotton rag and paper, nonplastic—WILMINGTON FIBRE
Phenolic plastic—OHMOID

# ANNOUNCING

## A NEW METHOD OF MOLDING MYCALEX

Of particular interest to the radio, electronic, industrial control and heating industries is a new development by the G-E Plastics Department — the injection molding of Mycalex, the superior insulator possessing low dielectric power losses and high temperature.

A material consisting of ground mica and a specially developed glass, Mycalex has been compression molded for some years in plate and bar form and machined to required designs. By the injection process, the material now can be produced in more intricate shapes and thus be available for applications.

G-E Mycalex has superior electrical characteristics and good mechanical strength. It has a low power factor, high arc resistance, chemical and dimensional stability and a low coefficient of thermal expansion. It is impervious to water, oil and gas and is unaffected by sudden temperature changes. Metallic inserts can be readily molded into the parts.

General Electric is molding Mycalex for rectifier seals, brush holder studs, tube bases, switch insulation, structural parts in radio transmitters, arc chutes, relay insulators, terminal insulators and as inserts in die castings and organic plastics. For further information write Section B-105, Plastics Department, General Electric Co., 1 Plastics Avenue, Pittsfield, Mass. PD-158

PLASTICS DEPARTMENT

GENERAL ELECTRIC

# Stampings Producers

*Reference letters beneath addresses of companies refer to: (a) Types, materials and sizes of stampings; (b) Names of stamped machine parts customarily produced; and (c) Machining, heat treating or assembling facilities.*

## A

**Accurate Spring Mfg. Co., 3811 W. Lake St., Chicago.**
(a) Blanking, forming and perforating all metals, small and medium sizes, specializing in spring materials.
(b) To customers' specifications.
(c) Complete facilities.

**Ace Hardware Mfg. Corp., 2020 E. Orleans St., Philadelphia.**
(a) Flat, drawn and formed stampings of all materials, 5-75 tons pressure capacity. Sizes 20 in. square light and heavy gages.
(b) To customers' specifications.
(c) Complete facilities.

**Acklin Stamping Co., 1925 Nebraska Ave., Toledo, O.**
(a) Pressed metal parts of steel, brass and aluminum to 40 in. dia., .010 to ⅜ in. metal thickness.
(b) To customers' specifications.
(c) Complete facilities.

**Aluminum Goods Mfg. Co., Washington St., Manitowoc, Wis.**
(a) Stampings, spinnings and deep drawings in aluminum, stainless steel and other metals.
(b) Refrigerator, radio, textile, electrical, airplane and automotive parts.
(c) Complete facilities.

**American Aluminum Ware Co., 368-378 Jelliff Ave., Newark, N. J.**
(a) Aluminum industrial stampings and spinnings.
(b) Pouring spouts, spools, reflectors, boxes, tubes, etc.
(c) Automatic spout inserting machine.

**American Emblem Co. Inc., Box D 116, Utica, N. Y.**
(a) Art metal and intricate stampings up to 16 in. square; .003 to .25-in. metal thickness.
(b) Embossed nameplates, radio escutcheons and dials and ornamental trim and stampings.
(c) Complete facilities.

**American Pulley Co., 4200 Wissahickon Ave., Philadelphia.**
(a) Pressed steel stampings in light to heavy steel gages; also deep drawn stampings.
(b) To customers' specifications.
(c) Complete facilities.

**Amesbury Metal Products Co., Inc., 39 Oakland St., Amesbury, Mass.**
(a) Stampings from deep drawn and cold rolled steel, brass, aluminum, nicral and copper.
(b) Marine lamp equipment, clock cases, mechanisms, and fluorescent lighting equipment.
(c) Complete facilities.

## B

**Barnes-Gibson-Raymond Div., Associated Spring Corp., 6391 Miller Ave., Detroit. (The Cook Plant—Ferry Field and Boulevard drive, Ann Arbor, Mich.)**
(a) Small flat springs and stampings from carbon and alloy steels and nonferrous metals.
(b) Special small stampings, formed flat wire parts, catches, clips, contacts, snap rings, retainers and washers.
(c) Complete facilities.

**Bossert Co. Inc., The, 1002 Oswego St., Utica, N. Y.**
(a) Stampings from .005 to 1 in. in thickness, any metal.
(b) Automotive, refrigeration, washing machine, radio, etc.
(c) Assembling and welding facilities.

**Brewer-Titchener Corp., The, 111 Port Watson St., Cortland, N. Y.**
(a) Flat, formed, and drawn stampings of ferrous and nonferrous, stainless, etc., up to 30 x 60 in. in size and 4 in. max. draw.
(b) To customers' specifications.
(c) Complete facilities.

**Bridgeport Chain & Mfg. Co., The, Bridgeport, Conn.**
(a) Small flat stampings of steel, brass and bronze, to .065 in. gage, 4 in. length or dia.
(b) To customers' specifications.
(c) Complete facilities.

**Budd, Edward G., Mfg. Co., Philadelphia. (Detroit branch located at 12141 Charlevoix Ave.)**
(a) Automobile body and large and small special stampings of mild and stainless steels.
(b) Automotive, chemical and rayon, railway cars, commercial trailers, marine and aircraft parts.
(c) Complete facilities.

**Buffalo Brake Beam Co., 140 Cedar St., New York.**
(a) Small stampings from light bars and strip stock.
(b) To customers' specifications.
(c) Information not available.

**By-Products Steel Corp., Coatesville, Pa.**
(a) Pressed heads and other pressed shapes in gages from No. 12 gage up to 6 inches thick.
(b) To customer's specifications.

## C

**Chapin, The R. E., Mfg. Works Inc., 29 Liberty St., Batavia, N. Y.**
(a) Blanks to 26-in. dia. light gage.
(b) Sprayers, atomizers, pumps, steel barrels.
(c) Machining.

**Chase Brass & Copper Co. Incorporated, 236 Grand St., Waterbury, Conn.**
(a) All types sheet metal stampings, drawn shells of brass, copper and copper alloys.
(b) All types of parts.
(c) Machining, polishing, plating and assembling facilities.

**City Auto Stamping Co., Lint and Dura Ave., Toledo, O.**
(a) Large light-gage stampings.
(b) Automotive.
(c) Assembling facilities.

**Cleveland Steel Products Corp., Plant No. 2, Wellington, O.**
(a) All types to 12 in. draw, 12 in. dia., ¼ in. thick.
(b) Automotive, industrial and electrical.
(c) Complete secondary operation, cyanide hardening, plating and assembling.

**Columbia Metal Stamping Co., The, 11900 Harvard Ave., Cleveland.**
(a) Light and medium stampings in all metals to ¼ in. thick, to 24 x 24 in. Deep drawn to 3½ in. deep, ⅛ thick.
(b) Automotive, electrical, industrial and general.
(c) Complete facilities.

**Commercial Shearing & Stamping Co., 1775 Logan St., Youngstown, O.**
(a) To 60 in., ¾-in. gage, steel and copper alloys, aluminum and stainless steel.
(b) Tank heads and water heater parts.
(c) Machining and assembling facilities.

**Cuyahoga Spring Co., The, 10301 Berea Rd., Cleveland.**
(a) Stampings of cold-rolled steel, up to No. 10 gage; flat springs stamped or formed and tempered for mechanical purposes; also brass, bronze stampings.
(b) Primarily flat springs.
(c) Complete facilities.

## D

**Dahlstrom Metallic Door Co., Buffalo St., Jamestown, N. Y.**
(a) Steel (stainless), brass, bronze, aluminum stampings and drawn parts. Press equipment Bliss 3-B to 7-E, and brake presses for sections 10 to 12 ft. long.
(b) Machine guards, cabinets, latches, brackets and special parts.
(c) Assembling facilities.

**Dayton Rogers Mfg. Co., 2830 S. 13th Ave., Minneapolis.**
(a) Stampings of steel, brass, copper and other sheet alloys, including bakelite and similar synthetics.
(b) Metal stampings in small lots for the aircraft industries including all instruments and other stamped products required in limited quantities.
(c) Pneumatic die cushions adaptable to all power presses for the sheet metal working trade.

**Diamond Expansion Bolt Co., Inc., Garwood, N. J.**
(a) Blanking, piercing and bending, strip steel, brass, copper and aluminum; from small to capacity of 70-ton press.
(b) Cable straps, toggle bolts, nuts, hammer drive anchors, etc.
(c) Complete facilities.

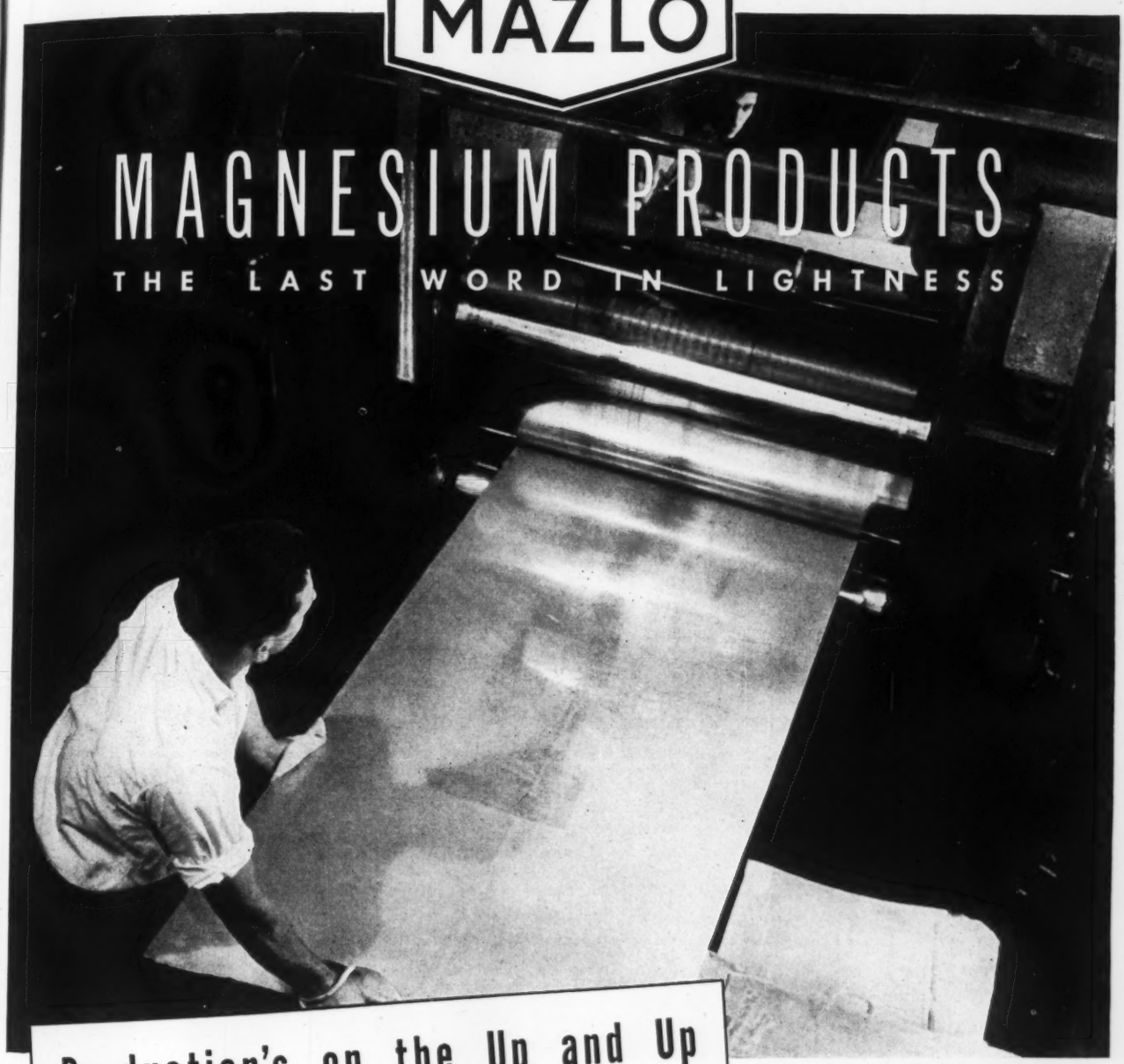
**Dill Mfg. Co., The, 700 E. 82nd St., Cleveland.**
(a) Small brass and steel stampings.
(b) Ferrules, etc.
(c) Machining and assembling.

**Duplex Mfg. Corp., Sherman, N. Y.**
(a) All type stampings of steel or galvanized sheets, small and large.
(b) Brackets, braces, airplane parts and other small parts.
(c) Complete facilities.

MAZLO

# MAGNESIUM PRODUCTS

THE LAST WORD IN LIGHTNESS



## Production's on the Up and Up

MAGNESIUM tonnage figures continue their spectacular climb. The high quality of Mazlo products is maintained, often improved, as techniques are further developed.

Mazlo Magnesium products are finding their way into National Defense in many forms. Sand castings are being made at Cleveland, Buffalo and Los Angeles; die castings at Garwood; forgings and permanent mold castings at Cleveland; tubing, extruded shapes and completely fabricated parts at New Kensington; pressings and screw machine products at Edgewater.

Long experience in manufacturing these various products, coupled with greatly expanded facilities and lengthened operating hours, make this speed possible. Meanwhile, the Magnesium industry is gaining valuable additional fabricating experience. Industry generally is finding new uses for it. As a result, everyone will profit, as metal again becomes available for normal markets.

MAZLO

REG. U.S. PAT. OFF.

### DEFENSE COMES FIRST

Magnesium, today, is "All Out for Defense." Civilian users have had to find substitutes. But we have not turned our backs. American Magnesium Corporation is increasing its fabricating facilities at a rate many times that required by normal peace-time markets. When the emergency is past, there will be an abundance of these lightweight products for all users. Sales Agent for Mazlo Magnesium products: Aluminum Company of America, 1703 Gulf Building, Pittsburgh, Pa.

AMERICAN MAGNESIUM CORPORATION

*Subsidiary of Aluminum Company of America*

## E

**Ennen, Geo. L., Co., 7 Emerick St., Ypsilanti, Mich.**
(a) Small steel stampings.
(b) Automotive.
(c) None.

**Erie Art Metal Co., 18th and Schaal Ave., Erie, Pa.**
(a) All types of sheet metal stampings, ferrous and nonferrous.
(b) Metal cabinets built to order, vault boxes, etc.
(c) Complete facilities.

**Eureka Tool & Machine Co., 17 W. 54th St., New York.**
(a) Small and medium stampings.
(b) To customers' specifications.
(c) Complete facilities.

## F

**Falstrom Co., 34 Main Ave., Passaic, N. J.**
(a) Fabricated steel parts of all kinds.
(b) Machine bases, frames, guards, instrument panels, etc.
(c) Machining and assembling facilities.

**Firestone Steel Products Co., Akron, O.**
(a) Blanking, forming and drawing metal stampings, hot and cold-rolled steel, stainless steel; in small or large sizes.
(b) Automotive and general machine parts.
(c) Information not available.

**Fox Co., Fox Bldg., Cincinnati.**
(a) Metal stampings.
(b) Nameplates, escutcheons, etc.
(c) Assembly facilities.

## G

**Geometric Stamping Co., The, 1111 E. 200th St., Cleveland.**
(a) Any type stampings in steel, stainless steel, brass, etc., ½ in. thick, 48 x 84 in.
(b) Dairy, washing machine, radio, railroad and automobile parts, etc.
(c) Complete facilities.

**Geuder, Paeschke & Frey Co., 324 N. 15th St., Milwaukee.**
(a) Deep drawn in all metals to 48 in. dia., 18 in. deep, 12-30 gage.
(b) Business and vending machine cases, tubs for electric washers, switch and transformer cases.
(c) Complete facilities.

**Gibson Co., William D., Div. of Associated Spring Corp., 1800 Clybourn Ave., Chicago.**
(a) Miscellaneous stampings of cold-rolled spring steel, stainless and alloys, small and medium.
(b) Springs.
(c) Heat treating facilities.

**Globe Machine & Stamping Co., 1250 W. 76th St., Cleveland.**
(a) Metal stampings of all sizes.
(b) Various types of parts, including stampings for tumbling and burnishing barrels.
(c) Machining and assembling facilities.

**Goat Metal Stampings Inc., 314 Dean St., Brooklyn.**
(a) Stamped, formed, drawn light sheet metal, steel, stainless steel, nickel, silver, tantalum, Monel, molybdenum, brass, copper, tin plate and zinc; .001 to ⅛ in., 1 to 10,000 per lb.
(b) Special cups, clips, caps, eyelets, etc.
(c) Light manufacturing and assembling.

**Grammes, L. F., & Sons Inc., Allentown, Pa.**
(a) Stampings of brass, aluminum, steel, etc.
(b) Automotive, radio, clock and electrical.
(c) Complete facilities.

**Gray, Peter, Corp., 290 Third St., Cambridge, Mass.**
(a) Steel and nonferrous metals, drawn, stamped and formed, up to 3/16 in. thick 5—400 tons with bed areas up to 25 sq. ft. Power hand brakes for 10 gage material by 8 ft. long.
(b) Handles, guards, stop motions, meters, fans, covers, radio, refrigerator casings, propeller heads, and textile machine parts.
(c) Complete assembling and some machining facilities.

**Greist Mfg. Co., The, New Haven, Conn.**
(a) Small stampings, specializing on forming operations.
(b) Business machine, photographic, electrical, sewing machine parts and assemblies.
(c) Complete facilities.

**Griffith-Hope Co., 6607 W. Mitchell St., West Allis, Wis.**
(a) Stampings of 30 gage to 10 gage drawn shapes, and shells up to 5 in. in depth.
(b) Paper-dispensing equipment, automobile stampings, etc.
(c) Assembling facilities.

## H, I

**Hagstrom Mfg. Co., 308 W. 19th Terrace, Kansas City, Mo.**
(a) Small stampings to 24 in. square, in all metals.
(b) Vending machine, etc.
(c) Machining facilities.

**Harvey Machine Co., 6200 Avalon Blvd., Los Angeles.**
(a) All kinds of blanking, deep drawing, forming in all metals. Sheet metal fabrication.
(b) All types of machine parts.
(c) Complete facilities.

**Hoosier Lamp & Stamping Corp., Evansville, Ind.**
(a) Light gage aluminum, stainless, Monel, brass, etc.
(b) Interior refrigerator parts, etc.
(c) Alumiliting, welding, all finishing and complete assembling.

**Hubbard, M. D., Spring Co., Pontiac, Mich.**
(a) Small stampings in spring steels, hot and cold-rolled steel, brass, bronze, aluminum, Monel and stainless steel.
(b) Expansion plugs, washers, flat springs and spring washers.
(c) Drilling, tapping, spot welding, and heat treating.

**Hunter Pressed Steel Co., Lansdale, Pa.**
(a) All types and materials up to ⅝-in. dia. stock.
(b) All types of machine parts.
(c) Complete facilities.

**Indiana Pressed Steel Co., Muncie, Ind.**
(a) Medium and medium-large stampings in all metals.
(b) Refrigerator, automotive, radio, electrical, etc.
(c) Complete facilities.

## K

**Kickhaefer Mfg. Co., 901 S. Second St., Milwaukee.**
(a) Small and medium stampings of steel, brass, copper and aluminum.
(b) Valve spring washers, special washers, tubing and wire clips, engine front and rear plates, plugs, etc.
(c) None.

**Klein Mfg. Co., Burlington, Ia.**
(a) Steel and galvanized iron stampings.
(b) To customers' specifications.
(c) Complete facilities.

## L

**Laminated Shim Co. Inc., Glenbrook, Conn.**
(a) Small, flat, brass; all types of steel, zinc, copper, etc.
(b) Shims and nuts.
(c) None.

**Leake Stamping Co., The, 1250 East First St., Monroe, Mich.**
(a) Drawn, formed, flat, steel, brass, copper and aluminum stampings in all sizes requiring up to 400-ton pressure with 20-inch stroke.
(b) To customer's specifications.
(c) Welding facilities.

**Lewyt Metal Products Co., 112 60 Broadway, New York.**
(a) Sheet metal stamping.
(b) Boxes, housings and cabinets.
(c) Machining and assembling facilities.

**Lukens Steel Co., Coatesville, Pa.**
(a) Pressed heads and other pressed shapes in gages from No. 12 gage up to 6 inches thick.
(b) To customer's specifications.

## M

**Milcor Steel Co., 4100 W. Burnham St., Milwaukee.**
(a) Flat, drawn, formed and intricate stampings of all types, in hot and cold rolled and galvanized sheets, copper, tin, etc., 16 gage to 30 gage; very small to medium large (6 sq. ft. max.)
(b) To customers' specifications.
(c) Complete machining and assembling.

**Morrison Products Inc., 16816 Waterloo Rd., Cleveland.**
(a) All gages up to ¼ in., deep drawn stampings up to 6 in. deep, in steel and other metals.
(b) All types of machine parts.
(c) Complete assembling, spotwelding, riveting, machining and japanning facilities.

**Mullins Mfg. Corp., Warren, O. (Another plant at Salem, O.)**
(a) Light and heavy gage stampings, light gage deep drawn stampings from 20 to 16 gage in sizes up to 80 x 160, depth of draw up to 22 in.
(b) Washing machine tubs, steel evaporators, and automobile parts.
(c) None.

**Murray Corp. of America, 7700 Russell St., Detroit.**
(a) Light and heavy stampings of any type.
(b) Auto bodies, fenders, hoods, frames, grilles and bodies.
(c) Assembling.

## N

**Nagel-Chase Mfg. Co., The, 2811-23 N. Ashland Ave., Chicago.**
(a) Pressed steel parts to 11 gage and about 20 in. dia.
(b) Pulleys for V-belts, washing machine casters, etc.
(c) Complete facilities.

**New England Pressed Steel Co., Washington Ave., Natick, Mass.**
(a) Stampings of steel, brass, copper, stainless steel and aluminum, small and medium.
(b) To customers' specifications.
(c) Heat treating, finishing and assembling facilities.

**Niles Steel Products Div., Republic Steel Corp., Elyria Works, Elyria, O.**
(a) Pressed steel to ½ in. thick.
(b) Automotive, tractor, sweeper, washing machine, etc.
(c) Some machining and assembling facilities.

**Noera Mfg. Co., Div. of Chase Brass & Copper Co. Incorporated, Waterbury, Conn.**
(a) Medium and light stampings of copper, brass, steel, 14 in. and smaller.
(b) Washers, oilers, etc.
(c) Assembling facilities.

**Nordendale Mfg. Co., 2100 Fulton St., Chicago.**
(a) Blanking, forming and drawing of steel, brass, aluminum, etc., on presses from 10-75 tons.
(b) To customers' specifications.
(c) Assembling and spot welding facilities.

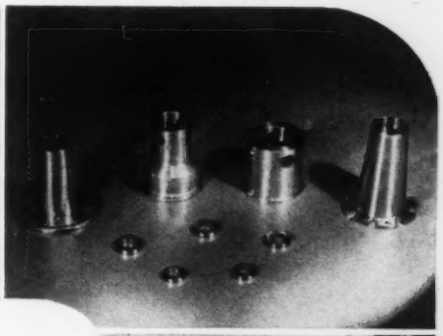
## O

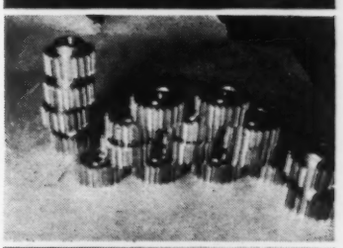
**O. K. Machine Co. Inc., Fairfield and Poplar Aves., Fort Wayne, Ind.**
(a) Stampings from smallest sizes to not exceeding 24 in. overall and not over 6 in. deep, of steel, brass, copper and aluminum.
(b) Laminations, cups, automatic photograph and radio, liquid dispensing pump parts, etc.
(c) Complete facilities.

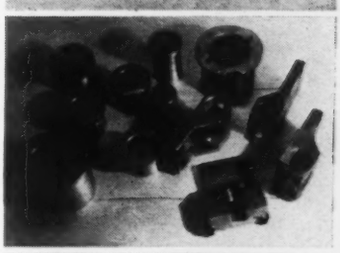
## P, Q

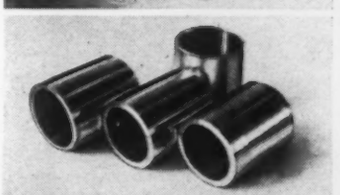
**Philadelphia Steel & Wire Corp., Penn St. and Belfield Ave., Philadelphia.**
(a) Punch press steel stampings, in all sizes suitable for presses up to 10 tons.
(b) To customers' specifications.
(c) Heat treating facilities.

**Plymouth Stamped Metal Co., The, 330-334 Harding Way St., Galion, O.**
(a) Small stampings.
(b) To customers' specifications.
(c) Complete facilities.









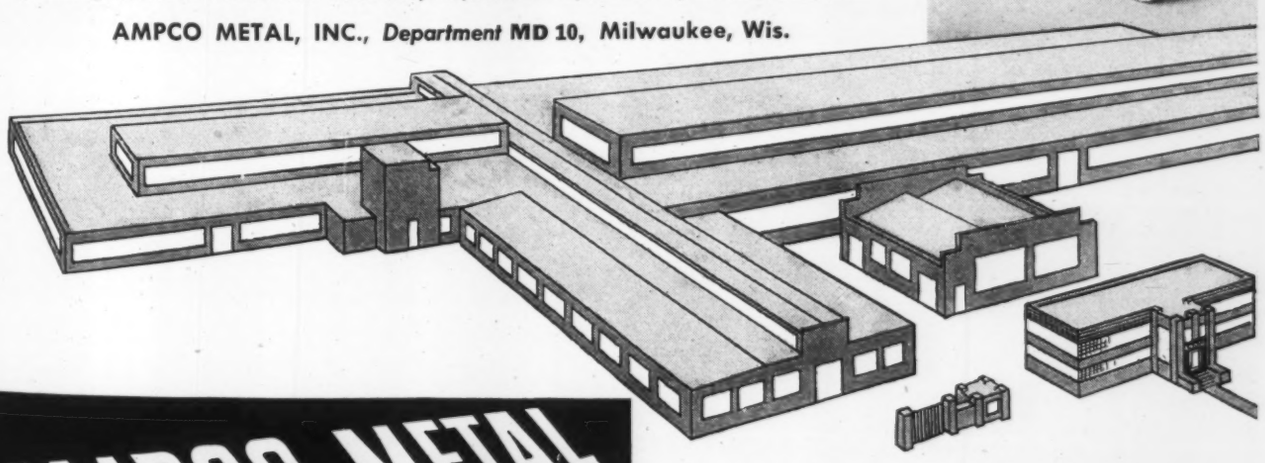
# In the Tools and Weapons of Defense

Like hundreds of other plants, the Ampco foundries are all out for defense. Today 98.5% of the output is devoted to defense activities. Ampco Metal and Ampco-made bronzes are being used in aircraft, machine tools, ordnance, and other equipment where the sturdy, wear-resistant qualities of Ampco alloys are essential.

For years before the defense program was under way, Ampco was serving American industries, helping build the quality for which American products are famous. The high tensile strength, controlled hardness, and resistance to wear and corrosion of Ampco-made bronzes were early recognized by designing engineers as necessary for satisfactory equipment performance.

Catalog number 22—brand new—shows why Ampco Metal is preferred by defense contractors.

**AMPCO METAL, INC.,** ***Department*** **MD 10, Milwaukee, Wis.**



AMPCO METAL
The Metal Without An Equal
AMPCO

AMPCO FOUNDRIES—plant capacity has been doubled, making this the largest foundry in the country devoted primarily to the production of aluminum bronzes of controlled analyses.

**Powell Pressed Steel Co., Hubbard, O.**
(a) All types of large or small stampings.
(b) Material handling equipment, automobile, refrigerator, washing machine parts, etc.
(c) Complete facilities.

## R

**Raymond Mfg. Co., Div. Associated Spring Corp., Corry, Pa.**
(a) Small stampings of steel, brass, phosphor bronze, Monel, etc.
(b) Springs, wire forms, etc.
(c) Heat treating facilities.

**Reliable Spring Co., The, 3167 Fulton Rd., Cleveland.**
(a) Blanking, forming, cutting of wire and strip in steel, stainless steel, brass, phosphor bronze, etc., flats 1/8 in. thick x 4 in. dia. and wire .006 in. to 3/8 in. dia.
(b) Springs, wire formations, bends, hooks, handles, clips, etc.
(c) Heat treating and assembling.

**Revere Products Corp., Phoenix, N. Y.**
(a) Blanking, forming or drawing from light metals, steel, bronze, copper, stainless steel, aluminum, and brass, blanking to 1/4 in. thick, forming to 36 in. long, drawing to 4 in. deep.
(b) Oil retainers, washers, escutcheons, etc.
(c) Complete facilities.

**Rockford Metal Specialty Co., 716 Cedar St., Rockford, Ill.**
(a) Drawing, forming, piercing of steel, stainless steel, aluminum, brass and zinc, approx. 10 in. dia. x 3 1/2 in. cups; up to 16 in. dia. or sq. on shallow parts.
(b) Automotive and general stamping.
(c) Plating, riveting, welding, assembling and enameling.

**Rockwood Sprinkler Co., 52 Harlow St., Worcester, Mass.**
(a) Medium-heavy deep drawing and stamping of brass, bronze, hot and cold-rolled steel, .02-.375 in. thick, 1-12 in. blank dia.
(b) Handles, pipe unions, textile, electrical and automatic machine parts.
(c) Machining, sherardizing, parkerizing facilities.

**Rome-Turney Radiator Co., Canal St., Rome, N. Y.**
(a) Copper, brass and steel stampings in sizes 15 x 30 x 6 in. deep.
(b) Refrigeration air heating and cooling.
(c) Gas and spot welding, machining.

## S

**Scovill Mfg. Co., Waterbury, Conn.**
(a) Brass, bronze, nickel silver, copper, aluminum, steel, and other metal stampings, drawn shells, formed parts and metal assemblies, nonferrous forgings.
(b) To customers' specifications.
(c) Complete facilities.

**Service Products Corp., 201 South Rural St., Indianapolis.**
(a) Blanking, forming, drawing, perforating, both heavy and light, of steel, brass aluminum, copper and bronze; draw 6 in. deep, blanking 28 x 36 in.
(b) Automotive fans, ventilators, etc.
(c) Heat treating and machining.

**Shunk Mfg. Co., Bucyrus, O.**
(a) Blanking, forming and perforating, all types of materials.
(b) To customers' specifications.
(c) Complete facilities.

**Standard Stamping Co. Inc., 530 W. Lovett St., Charlotte, Mich.**
(a) Small metal stampings.
(b) Rolled bushings, split steel spacer tubes, spring clips, etc.
(c) Cyanide furnace, lathes, screw machine, etc.

**Stolper Steel Products Corp., 3258 W. Fond du Lac Ave., Milwaukee.**
(a) All types of sheet metal up to quarter inch.
(b) For automotive, agricultural, and industrial fields.
(c) Complete assembling facilities, welding.

## T

**Textile Shield Co., 1 Groton St., Lawrence, Mass.**
(a) All kinds, up to 1/16 in. thick, specializing in deep drawn work.
(b) Radio and auto parts, ferrules, etc.
(c) Annealing facilities.

**Toledo Stamping & Mfg. Co., 99 Fearing Blvd., Toledo, O.**
(a) Small, medium and large stampings.
(b) Automotive, tractor, washing machine and radio parts.
(c) Heat treating and assembling facilities.

**Transue & Williams Steel Forging Corp., Alliance, O.**
(a) Medium-sized stampings, blanked, formed, pierced and drawn, from hot and cold rolled steel, stainless steel, aluminum and Monel metal.
(b) All sizes and types of parts.
(c) Welding, brazing, punching and riveting.

**Truscon Steel Co., Pressed Steel Division, 6100 Truscon Ave., Cleveland.**
(a) From 20-gage to heavier gage stampings.
(b) Refrigerator, automotive, housings, washing machine etc.
(c) None.

## W

**Wall Mfg. Supply Co., P., 3126 Preble Ave., Pittsburgh.**
(a) Drawn, max. blank 20 in., max. gage 16; flat in gages from 12 to 30 inclusive; of steel, brass, copper, etc.
(b) To customers' specifications.
(c) Complete facilities.

**Western Cartridge Co., East Alton, Ill.**
(a) Brass, bronze, phosphor bronze, nickel silver, sheets, strips, coils.
(b) To customer's specifications.

**Whitehead Stamping Co., 1661 W. Lafayette Blvd., Detroit.**
(a) Light, medium and heavy stampings.
(b) S.A.E. standard, U. S. standard, steel and brass washers.
(c) Complete facilities.

**Williams, H. E., Products Co., 100-122 S. Main St., Carthage, Mo.**
(a) Light stampings, sheet metal fabrication, steel and nonferrous metals, press size to 80 tons capacity.
(b) Automotive, electrical fluorescent light fixtures, etc.
(c) Turret lathes, spot welders, plating, ovens for baking finishes.

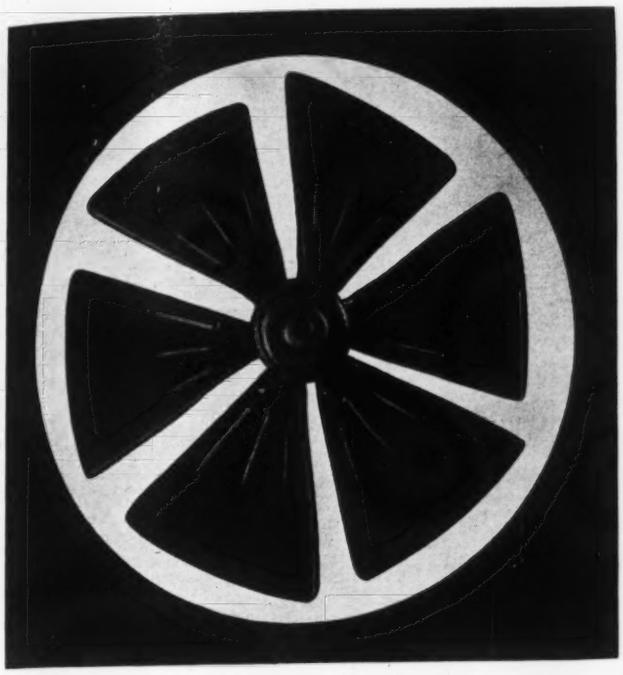
**Winchester Repeating Arms Co., Div. of Western Cartridge Co., New Haven, Conn.**
(a) Brass, copper and copper alloy stampings and shells.
(b) To customers' specifications.
(c) Machining, polishing and plating.

**Winzeler Manufacturing & Tool Co., 2145 W. Walnut St., Chicago.**
(a) Stampings to 90 tons of brass, aluminum, steel and plastics.
(b) Gear specialties, switches, etc.
(c) All assembling and finishing.

**Worcester Pressed Steel Co., 111 Barber Ave., Worcester, Mass.**
(a) Pressed metal stampings from 1/2 in. to 4 ft. dia., in lengths up to 7 ft., using material from .0002 to 1/2 in. thick, cold forgings at 1000 tons pressure.
(b) Automotive, airplane, oil burner, vacuum cleaner, transmission parts, etc.
(c) Complete facilities.
*See advertisement Page 81-D*

**Worcester Stamped Metal Co. Inc., 9 Hunt St., Worcester, Mass.**
(a) Light and heavy stampings of steel, brass, aluminum, copper and stainless steel, large and small.
(b) To customers' specifications.
(c) Annealing and hardening facilities.

**Wrought Washer Mfg. Co., 2102 S. Bay St., Milwaukee.**
(a) Stampings, blanking, forming, drawing, extruding, in all ferrous and nonferrous metals. Presses 300 ton capacity; material up to 1 1/4 in. thick.
(b) Washers, expansion plugs, automotive, etc.
(c) Complete facilities.



# Protected by Rubber

THIS EXHAUST FAN was covered with rubber to protect it against chemical fumes, condensation and other unfavorable conditions that quickly attack metal. This is just one of the many different products, and parts of machines that we have covered with rubber. We also rubber-line tanks of a variety of sizes.

**During the past 50 years we have manufactured rubber rolls and mechanical rubber products for the paper, textile, tobacco, tanning, hat, steel and other industries.**

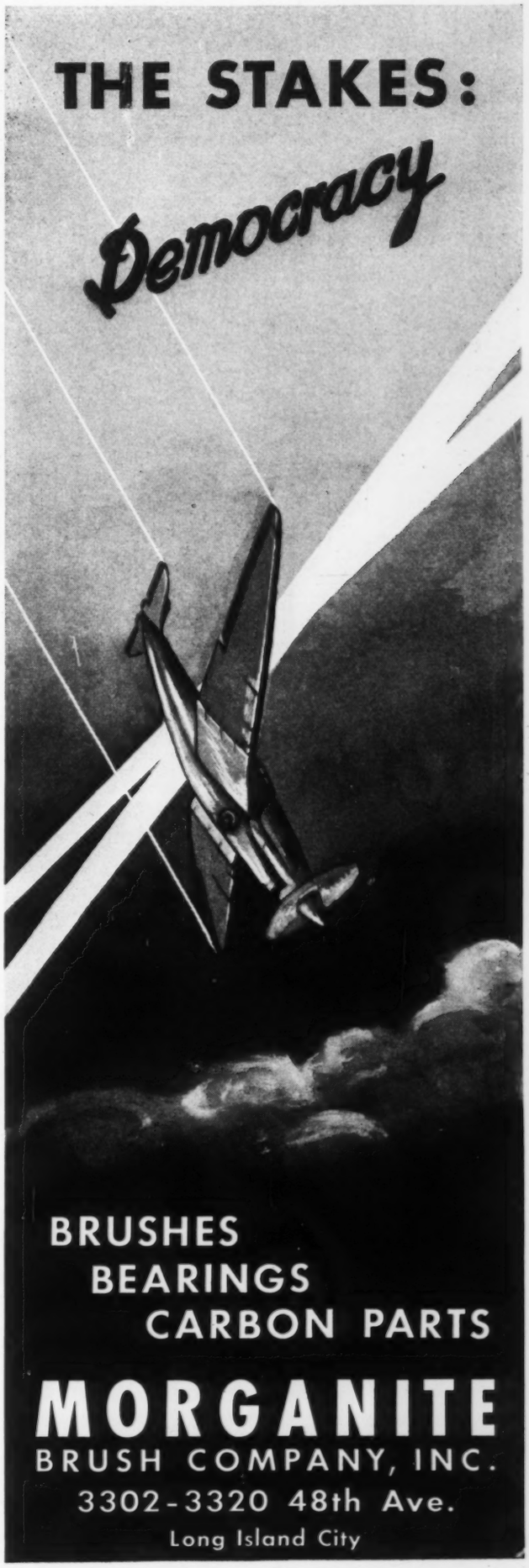
Are there any parts of the machines you are now designing that require protection against unfavorable conditions? If so, tell us your problem. We'll gladly give you the benefit of our experience.

* * *

Possibly there are places where rubber rolls could be used to advantage in those machines—where they would do a better job or where they may be used to replace rolls difficult to secure during the defense program. If so, write us.

AMERICAN WRINGER COMPANY, INC.
Woonsocket, R. I.

**TENSILASTIC**



# Forgings Producers

*Reference letters beneath addresses of companies refer to: (a) Types, materials and sizes of forgings; (b) Names of forged machine parts customarily produced; and (c) Machining or heat treating facilities.*

## A

**Allegheny Ludlum Steel Corp., Oliver Bldg., Pittsburgh.**
(a) Disks to 24 in. dia. x 5 in. thick; rings, max. 24 in. o.d. x 20 in. i.d. x 4 in. thick; also special shapes; of high speed steels, alloy and carbon tool steels, stainless and Nitralloy.
(b) Hardened machine parts, etc.
(c) Complete facilities.

**Alliance Drop Forging Co., P. O. Box 427, Alliance, O.**
(a) Drop forgings.
(b) To customers' specifications.
(c) Shot-blasting, not machining or treating.

**Aluminum Company of America, Gulf Bldg., Pittsburgh.**
(a) Aluminum and magnesium alloy hammered and pressed forgings, in any sizes.
(b) Largely aircraft and aircraft engine parts.
(c) Heat treating facilities.

**American Brass Co., Waterbury, Conn.**
(a) Hot-pressed copper, brass, bronze, nickel silver, and special copper alloys in small sizes and shapes.
(b) To customers' specifications.
(c) None.
*See advertisement, Pages 17-D—20-D*

**American-Forge Div., 2621 S. Hague Ave., Chicago.**
(a) Drop and upset forgings, of alloy and carbon steel.
(b) To customers' specifications.
(c) Complete heat treating facilities.

**American Hollow Boring Co., Erie, Pa.**
(a) Hollow-bored forgings.
(b) Piston rods, clutch shafts, hydraulic cylinders, etc.
(c) Complete facilities.
*See advertisement, Page 89-D*

**American Magnesium Corp., 2210 Harvard Ave., Cleveland.**
(a) Hammered and pressed forgings, of magnesium alloys, in any size.
(b) To customers' specifications.
(c) Heat treating facilities.
*See advertisement, Page 69-D*

**Atlas Drop Forge Co., 209 W. Mount Hope Ave., Lansing, Mich.**
(a) All sizes and shapes, any material, from few ounces to 500 lbs.
(b) Farm implements, tractors, railroad, aviation, automotive, etc.
(c) Complete heat treating facilities.

**Atwater Mfg. Co., Plantsville, Conn.**
(a) Drop and upset forgings of steel up to 20 lbs.
(b) To customers' specifications.
(c) Heat treatment.

## B

**Benton Harbor Malleable Industries, Benton Harbor, Mich.**
(a) Drop hammer steel forgings to 80 pounds.
(b) To customers' specifications.
(c) Heat treating facilities.

**Bethlehem Steel Co., Bethlehem, Pa.**
(a) Open die forgings to 225,000 lbs. in all grades of carbon and alloy steels—solid and hollow. Drop forgings from 1 lb. to 350 lbs. Also upset forgings.
(b) Shafts, rotors, rolls, gears and other press and hammer forgings.
(c) Complete facilities.

**Billings & Spencer Co., The, 1 Laurel St., Hartford, Conn.**
(a) All types in brass, bronze, stainless steel, alloys, straight carbon steel, Monel metal and tool steel; to 100 lbs.
(b) Airplane, automobile, machine tool parts, gas and diesel engine, conveyor, mining machinery, typewriter parts, etc.
(c) Complete facilities.

**Blakeslee Forging Co., The, Plantsville, Conn.**
(a) Light drop forgings to 25 lbs., all grades steel, brass, bronze and copper.
(b) To customers' specifications.
(c) Machining, normalizing and annealing.

**Bonney Forge & Tool Works, Allentown, Pa.**
(a) Drop forging from 1 ounce to 8 lbs. of any grade steel, alloy or carbon; also small upset forgings.
(b) Machine handles, etc.
(c) Complete facilities.

**Brewer-Titchener Corp., 111 Port Watson St., Cortland, N. Y.**
(a) Ferrous, drop and upset forgings up to 28 lb.
(b) Automotive and custom drop forgings.
(c) Complete facilities.

**Buckeye Forging Co., 10003 Harvard Ave., Cleveland.**
(a) Small forgings of carbon and alloy steels, stainless steels, brass and copper.
(b) Automotive, tractor, tank, etc.
(c) Machining facilities.

## C

**Canton Drop Forging & Mfg. Co., Canton.**
(a) Drop, upset, rolled and hammered forgings in steel only, up to 600 lb. each.
(b) Parts for aircraft engines, propellers, planes, automotive cars and trucks.
(c) Complete heat treating.

**Cape Ann Tool Co., 146 Granite St., Pigeon Cove, Mass.**
(a) All types and sizes of drop and upset forgings in ferrous and nonferrous metals.
(b) To customers' specifications.
(c) Heat treating facilities.

**Carnegie-Illinois Steel Corp., 434 Fifth Ave., Pittsburgh.**
(a) All type forgings produced with open dies, in all types of steel. Round—body diameter 68 in., max. collar diameter, 90 in., max. weight 220,000 lbs. Rectangular—up to 30 in. max. thickness, 150 in. max. width, with max. weight of 220,000 lbs. Hollow rounds —max. outside diameter 140 in.
(b) Axles, bars, bridge pins, hexagon shafts, propeller shafts, rotors, locomotive parts, back-up rolls, sleeves, pinions, reduction gears, mill housings, etc.
(c) Complete facilities.

**Carpenter Steel Co., The, 120 Bern St., Reading, Pa.**
(a) Simple forgings made on flat dies in all S.A.E., stainless and tool steels up to 3000 lbs.
(b) Rings, disks, blocks, simple shafts, axles, etc.
(c) All heat treating facilities; minimum of machine work.
*See advertisement, Pages 12-D - 13-D*

**Champion Machine & Forging Co., 3695 E. 78 St., Cleveland.**
(a) All type steel forgings to 800 lbs.
(b) To customers' specifications.
(c) Complete facilities.

**Chase Brass & Copper Co. Incorporated, 236 Grand St., Waterbury, Conn.**
(a) Brass, naval brass, copper and copper alloy, and Olympic bronze.
(b) Automotive, aircraft, refrigeration parts, air valves, etc.
(c) Annealing, machining, polishing and plating facilities.

**Clapp, E. D., Mfg. Co., 305 Genesee St., Auburn, N. J.**
(a) Drop forgings of stainless steel, Monel, brass, bronze, copper, etc.
(b) Aircraft, automotive, railroad, tractor, etc.
(c) Complete facilities.

**Cleveland City Forge Co., 4501 Lakeside Ave., Cleveland.**
(a) Drop and upset forgings of carbon and alloy steel, from few ounces to several hundred pounds.
(b) To customers' specifications.
(c) Complete facilities.

**Cleveland Hardware & Forging Co., 3270 E. 79th St., Cleveland.**
(a) Drop and upset forgings in steel and brass.
(b) To customers' specifications.
(c) Complete facilities.

**Clifford-Jacobs Forging Co., Box 264, Champaign, Ill.**
(a) Drop forgings.
(b) Steel flanges, center plates, wedges, hubs, gears, conn. rods.
(c) Information not available.

**Cornell Forge Co., 1659 W. 74th St., Chicago.**
(a) All type drop forgings, from fraction of an ounce to 15 lbs.; carbon steel, alloy, Monel, stainless steel.
(b) Cams, crankshafts, pins, gears, hubs, valves, connecting rods, etc.
(c) Heat treating, annealing, sandblasting and some machining.

**Crucible Steel Co. of America, 405 Lexington Ave., New York.**
(a) All types of forgings in carbon and alloy grades, to 40 tons max. weight.
(b) Crankshafts, propeller shafts, piston rods, rams, gun forgings, etc.
(c) Complete facilities.

## D

**Davenport Besler Corp., 2205 Rockingham Rd., Davenport, Ia.**
(a) Drop forgings and open steam hammer forgings.
(b) Crankshafts, connecting rods, levers, automotive and railway equipment.
(c) Complete facilities.

**Delaware Alloy Forge Co., 2300 E. Tioga St., Philadelphia.**
(a) Flat die steam hammer work in stainless steel, tool steel, Nitralloy, Monel metal, bronze and other alloys from 1-5000 lbs.
(b) Seat rings for large valves, knitting machine cylinders, paper machinery shafts, and gears.
(c) Complete facilities.

**Dow Chemical Co., The, Midland, Mich.**
(a) Magnesium alloy forgings.
(b) To customers' specifications.
(c) Heat treating facilities.
*See advertisement, Page 3-D*

**Drop Dies & Forgings Co., 3097 E. 61st St., Cleveland.**
(a) Drop forgings up to 25 lbs.
(b) To customers' specifications.
(c) None.

## E

**Ellwood City Forge Co., Box 589, Ellwood City, Pa.**
(a) Steel forgings from 25 to 35,000 lbs.
(b) Crankshafts, aircraft, automobile, gas,

# TWO VALUABLE BOOKS–

**For Your Metallurgical Library**

## "MOLYBDENUM IN STEEL" *and* "MOLYBDENUM IN CAST IRON"

More than ever before improved materials are imperative to meet increasing costs and competition and severe service conditions. Molybdenum steels and irons, Industry's modern materials, continue to prove themselves the answer to many ferrous problems.

The most recent, thorough and authoritative data on Molybdenum in steel and iron will be found in two books compiled and published by the Climax Molybdenum Company: "Molybdenum In Steel" and "Molybdenum In Cast Iron".

Either or both of these important technical books will be sent on request to any company or individual actively interested in the metallurgy and application of ferrous materials. There is neither charge nor obligation involved.

Additional information on Molybdenum steels and irons will gladly be supplied those with special problems on receipt of sufficiently detailed information with regard to the requirements to be met. It will pay you to re-study your material specifications.

**Climax Mo-lyb-den-um Company**
**500 Fifth Avenue · New York City**

MOLY

steam, or diesel engines.
(c) Complete facilities.

**Endicott Forging & Mfg. Co. Inc., Endicott, N. Y.**
(a) Drop and upset forgings, of carbon and alloy steels, Monel, stainless, Nitralloy, brass, copper and bronze, from 2 ozs. to 80 lbs.
(b) Gear blanks, crankshafts, connecting rods, rocker arms, etc.
(c) Heat treating facilities.

**Erie Forge Co., Erie, Pa.**
(a) Flat die, press and hammered steel forgings.
(b) Marine and stationary engine crankshafts, etc.
(c) Complete facilities.

## F

**Falleen Drop Forge Corp., Filer City, Manistee Co., Mich.**
(a) Steam hammer and upset forgings in carbon and alloy steels, ½ to 45 lb.
(b) To customers' specifications.
(c) Heat treating facilities.

**Federal Drop Forge Co., 2200 S. Washington Ave., Lansing, Mich.**
(a) Drop forgings up to 25 lbs.
(b) To customers' specifications.
(c) Information not available.

**Finkl, A., & Sons Co., 2011 N. Southport Ave., Chicago.**
(a) Hammer and press forgings in carbon and alloy steels from 5-50,000 lbs.
(b) Shafts, rolls, rings, gear and pinion blanks, etc.
(c) Complete facilities.

**Forging & Casting Corp., The, 1350 Jarvis Ave., Ferndale, Mich.**
(a) Smooth hammered forgings, of S.A.E. grades of steel, from ½ lb.-1500 lbs.
(b) Rings, blocks, disks, and irregular shapes.
(c) Annealing facilities.

**Forgings & Stampings Inc., 23rd Ave. and Seventh St., Rockford, Ill.**
(a) Drop forgings.
(b) To customers' specifications.
(c) Information not available.

## G

**Gardiner Mfg. Co., 2707 Union St., Oakland, Calif.**
(a) Drop forgings up to 2 lb. and also hammer and upset forgings.
(b) Gearshift levers, etc.
(c) Machining facilities.

**General Drop Forge Co. Inc., 1738 Elmwood Ave., Buffalo.**
(a) Hammered and upset forgings, of carbon, stainless, Monel and alloys, 1 oz.-100 lbs.
(b) Rings, gears, stem pinions, side gears, connecting rods, etc.
(c) Heat treating facilities.

**Globe Forge & Foundries Inc., Peat Street, Syracuse, N. Y.**
(a) Drop and upset forgings in carbon and alloys from few ounces to 125 lbs.
(b) Differential, transmission gears.
(c) Complete facilities.

## H, I

**Hammond & Irving Inc., 254 North St., Auburn, N. Y.**
(a) Steam hammer forgings in alloy and tool steels, stainless, Nitralloy and Monel metals, up to 1200 lbs.
(b) Weldless rings, gear blanks, shafts, hammered bars, etc.
(c) Complete facilities.

**Harris-Thomas Drop Forge Co., 126 Harshman St., Dayton, O.**
(a) Drop forgings.
(b) To customers' specifications.
(c) Information not available.

**Harrisburg Steel Corp., 10th and Herr Sts., Harrisburg, Pa.**
(a) Alloy and carbon open hearth steel drop forgings which can be produced on steam drop hammers from 2000 to 8000 lbs.
(b) All types of machine parts.
(c) Complete facilities.

**Hartford Drop Forge Div., Capewell Mfg. Co., 846 Windsor St., Hartford, Conn.**
(a) Die and drop forgings in steel, copper, brass, Monel, up to 7 lbs.
(b) Gears, levers, loom parts, and any part to customers' specifications.
(c) None.

**Henry & Allen Inc., 2-36 Wadsworth St., Auburn, N. Y.**
(a) Drop and hammered forgings of carbon and alloy steel, under 1 lb. to 12 lb.
(b) Agricultural, automobile and commercial.
(c) Complete heat treating facilities.

**Heppenstall Co., 4622 Hatfield St., Pittsburgh.**
(a) Forgings of carbon, alloys, and steels, up to 45,000 lbs. rough turned weight.
(b) Shafts, crankshafts, die blocks, shear knives, rolls, etc.
(c) Complete facilities.

**Herbrand Corp., Fremont, O.**
(a) Drop forgings.
(b) Automobile, etc.
(c) Heat treating facilities.

**Indiana Forge & Machine Co., Indiana Harbor Station, East Chicago.**
(a) Steel drop forgings up to 4 lb.
(b) Clutch hubs.

**Indianapolis Drop Forging Co., 1300 Madison Ave., Indianapolis.**
(a) Hammered and drop forgings in steel, carbon, alloy and stainless up to 50 lb. drop, 500 lb. hammered.
(b) To customers' specifications.
(c) Complete facilities.

**Interstate Drop Forge Co., 4041 N. 27th St., Milwaukee.**
(a) Drop and upset forgings of carbon, alloy and stainless steel.
(b) Levers, gears, segments, hydraulic fittings, connecting rods, crankshafts, etc.
(c) Heat treating facilities.

## J

**Jersey Forging Works, 803 Jersey Ave., Jersey City, N. J.**
(a) Alloy steel and Standard S.A.E. steel forgings.
(b) Gear blanks, rings, sleeves, rolls, shafts, spindles, etc.
(c) Complete facilities.

**Johnston & Jennings Co., 877 Addison Rd., Cleveland.**
(a) Flat die forgings in plain carbon and alloy steels, 1 lb. to 5 tons.
(b) Spindles, solid and hollow-bored; rings; arbors, shafts, gears, etc.
(c) Complete machine shop facilities.

**Jones & Laughlin Steel Corp., Third and Ross St., Pittsburgh.**
(a) Smooth, rough turned and finished forgings of any size.
(b) To customers' specifications.
(c) Annealing, normalizing and heat treating.

## K

**Keystone Forging Co., Northumberland, Pa.**
(a) Drop forgings of steel, brass and other alloys not exceeding 3 lb.
(b) To customers' specifications.
(c) Complete facilities.

**Kortick Mfg. Co., 345 First St., San Francisco.**
(a) Drop forgings.
(b) Bolts, nuts, washers, etc.
(c) Information not available.

**Kraeuter & Co. Inc., 585 Eighteenth Ave., Newark, N. J. (Drop Forging Div., Nye Ave. and S. Twentieth St., Irvington, N. J.)**
(a) Closed die and upset forgings, of carbon, Monel, stainless steel, bronze and alloy steels, ½ oz. to 20 lbs.
(b) To customers' specifications.
(c) Limited facilities.

**Kropp Forge Co., 5301 W. Roosevelt Rd., Chicago.**
(a) Steam hammer to 20 tons; drop and upset.
(b) To customers' specifications; merchant bars, die blocks, flanges.
(c) Machining, heat treating, Magnaflux inspection.

## L

**Lakeview Forge & Clevis Co., Pittsburgh Ave., Erie, Pa.**
(a) Drop forgings up to 10 lbs. in alloy or carbon steel.
(b) To customers' specifications.
(c) Heat treating facilities.

**Lamson & Sessions Co., The, Cleveland, Kent, Chicago and Birmingham, Ala.**
(a) Small hot and cold upset forgings of any metal or alloy.
(b) Bolts, nuts, cotters, cap screws and special hot and cold upset products.
(c) Complete facilities.

**Lansing Drop Forge Co., Logan and Albert Sts., Lansing, Mich.**
(a) Drop forgings to 80 lbs., upset forgings, coined and machined forgings, of all grades of carbon, Monel metal, aluminum and other alloys, from 2 ozs. to about 80 lbs.
(b) Steering arms, shift levers, small crankshafts, camshafts, shock absorber arms, rocker arms, gears, housings, etc.
(c) Complete facilities.

**Latrobe Electric Steel Co., Latrobe, Pa.**
(a) High speed steel and stainless steel forgings, blocks approx. 16 in. cube, flats approx. 20 x 10.
(b) Shear blades, disks, etc.
(c) Heat treating facilities.

**Leard, William, Co. Inc., New Brighton, Pa.**
(a) Hammered and hydraulic pressed steel forgings up to 25,000 lbs.
(b) Crankshafts, connecting rods and other type forged steel shafts.
(c) Complete facilities.

**Letts Drop Forge Inc., 2714 W. Jefferson Ave., Detroit.**
(a) Small and medium drop forgings in carbon and alloy bar stock.
(b) Automotive parts.
(c) None.

**Lindell Drop Forge Co., S. Logan and N. Y. C. R. R., Lansing, Mich.**
(a) Carbon and alloy steel forgings, from 1 oz. to 75 lbs.
(b) For automotive, agricultural, mining machinery, etc.
(c) Limited machining.

## M

**Machinery Forging Co., The, 5450 Hamilton Ave., Cleveland.**
(a) Flat die forgings of carbon and alloy steels, 1 to 2000 lbs.
(b) Rings, disks, blocks, spindles, bars, hubs, etc.
(c) Rough turning only.

**Melling Forging Co., 1401 Case St., Lansing, Mich.**
(a) Steel drop forgings; from 1 oz. to 8 lbs.
(b) To customers' specifications.
(c) Complete facilities.

**Merrill Brothers, 56 Arnold Ave., Maspeth, Queens, N. Y.**
(a) Drop forgings of steel and alloys, from fraction of oz. to 100 lbs. or more.
(b) Turnbuckles, clevis nuts, shackles, eyebolts, hexagon sleeve nuts, etc.
(c) Complete facilities.

**Mesta Machine Co., Box 1466, Pittsburgh.**
(a) Very large steel and alloy steel forgings, both hollow and solid.
(b) Shafts, pinions, rolls, high pressure cylinders and reaction vessels.
(c) Complete facilities.

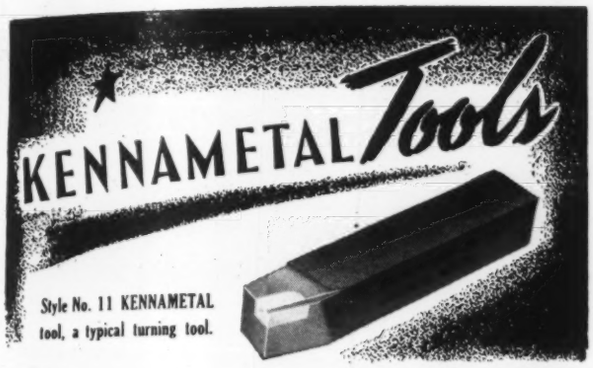
**Midvale Co., The, Nicetown, Philadelphia.**
(a) Press or hammer forgings, solid or hollow, in carbon or alloy steel.
(b) All types of parts.
(c) Complete facilities.

**Mitchell Steel Co., The, Stockyards Station, Cincinnati.**
(a) Steam hammer forgings in plain carbon, alloy and stainless steel.
(b) All types of machine parts, railroad, marine, etc.
(c) Complete facilities.

**Modern Die & Drop Forge Co., 2600 W. 139th St., Blue Island, Ill.**
(a) Drop forgings.
(b) To customers' specifications.
(c) Information not available.

**Mondie Forge Co. Inc., 10300 Berea Rd., Cleveland.**
(a) Drop forgings up to 75 lbs., upset forgings to 4 in., also gear blanks.
(b) To customers' specifications.
(c) Machining facilities.

**Moore Drop Forging Co., 36 Walter St., Springfield, Mass.**
(a) Drop, upset and coined forgings.
(b) To customers' specifications.
(c) Heat treating and machining.




## PERMIT USE OF HARDENED STEEL PARTS IN ARMAMENT MANUFACTURE WITHOUT PRODUCTION DELAYS

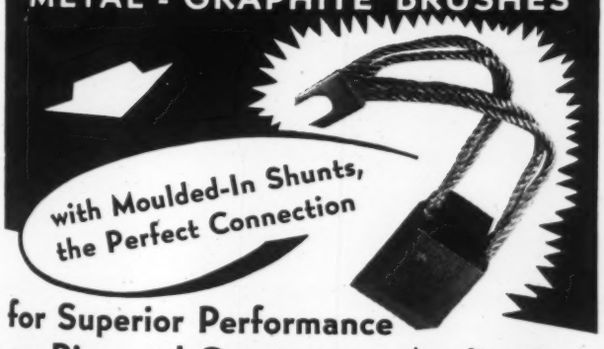
Many of the steel parts required in the manufacture of armaments must be heat treated to hardnesses of over 350 Brinell. Often these specifications apply to intricate shapes and combinations of thick and thin sections which are virtually impossible to quench without considerable warpage.

The answer has been to machine *after* heat treatment. KENNAMETAL, the steel-cutting carbide, machines parts up to 550 Brinell with speed and accuracy, allowing heat treatment to any practical degree of hardness before machining.

If heat treating difficulties have forced you to "compromise" your designs, investigate KENNAMETAL. Free literature on request.

McKENNA METALS Co.
146 LLOYD AVENUE, LATROBE, PA.
FOREIGN REPRESENTATIVES: U. S. STEEL EXPORT CO.
(Exclusive of Canada, Great Britain and Possessions)

KEYSTONE
METAL - GRAPHITE BRUSHES




## for Superior Performance on Ring and Commutator Applications

Keystone Metal-Graphite brushes are giving outstanding service on low voltage generator and on slip ring applications. Principal characteristics of Keystone Metal-Graphite brushes include low specific resistance, high current carrying capacity, low friction coefficient, cool operation, and long life. The Moulded-In Shunts are an integral part of the brush itself . . . will not work loose, and eliminate shunt contact resistance entirely.

Keystone also makes high quality carbon-graphite brushes for standard voltage applications. Send for our free catalog—today.

KEYSTONE CARBON CO., INC.
1935 STATE ST. SAINT MARYS, PENNA.

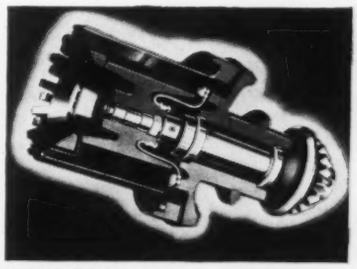
## DUREZ offers a wide choice of phenolic molding materials

With hundreds of molding compounds and with more than a decade of research and service to hundreds of manufacturers—Durez has come to be known as the "No. 1 industrial plastic."

Wherever phenolic plastics can be used—and the applications are almost endless—you'll find a place for Durez, and a Durez plastic "to fit the job." Whatever your molding problems, you'll find us ready and able to help you choose—or create—a Durez material to solve it. For information, write

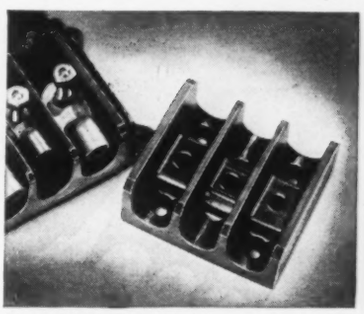
DUREZ PLASTICS & CHEMICALS, INC.
41 Walck Road North Tonawanda, N. Y.

**BILGE PUMP HOUSINGS** had always been made of metal, until it was found that plastics could do the job better. But only one plastic—Durez 75—could do the job *perfectly*.



**MIRACLE IN RAYON** . . . After 4 years' experiments, a Durez plastic proved the ultimate solution in the development of a reel for the continuous processing of rayon! To qualify, the molded Durez reel had to be impervious to water, acid, a desulphuring liquid, a bleaching solution and oil!

**MOLDED PARTS** that must be machined or sanded require a molding compound that withstands abrasion. Durez 114SB is one of the best materials of this kind you can get to meet this condition.



**HIGH IMPACT PLASTICS** were always difficult to pre-form until Durez came along with 1900—a material that preforms easily and molds with smooth finish. It has exceptionally high dielectric strength, too.

DUREZ PLASTICS & CHEMICALS, INC.
Plastics that Fit The Job

## N

**National Forge & Ordnance Co., Irvine, Warren Co., Pa.**
(a) Flat die press and hammered steel forgings.
(b) Heavy-duty crankshafts, etc.
(c) Complete facilities.

**National Lock Washer Co., 40 Hermon St., Newark, N. J.**
(a) Small drop forgings.
(b) Steel rod ends in adjustable yoke, plain yoke and eye types; steel clevis pins for steel rod ends; steel plugs, rings, and flanges, all in standard sizes, etc.
(c) Heat treating and machining.

## O

**Octigan Forge Co., 2824 S. Lowe Ave., Chicago.**
(a) Drop forgings.
(b) To customers' specifications.
(c) None.

**Ohio Forge & Machine Corp., 3010 Woodhill Rd., Cleveland.**
(a) Drop, upset and flat hammer steel forgings in all sizes.
(b) Gear blanks and other machine parts.
(c) Complete heat treating, machining for gears and shafts only.

**O'Leary & Son Co., Arthur J., 5757 West 65th St., Chicago.**
(a) Upset and steam hammered forgings of medium and mild steels and alloys, to 5 in. dia. upsetting and to 10 in. dia. steam hammer.
(b) Eye bolts, special bolts, upset bolts, fabricated steel parts, upset links, etc., and to customers' specifications.
(c) Complete facilities.

**Oliver Iron & Steel Corp., N. E. Corner S. 10th and Muriel Sts., Pittsburgh.**
(a) Small forgings in iron, steel and alloys in sizes of 8 in., and weight of 5 lbs. Large and small upset bars.
(b) Bolts, nuts, rivets, hot or cold headed special parts of all kinds.
(c) Complete facilities.

**Owensboro Forging Co., Owensboro, Ky.**
(a) Drop forgings.
(b) To customers' specifications.
(c) Heat treating facilities.

## P

**Park Drop Forge Co., The, 730 E. 79th St., Cleveland.**
(a) All types of drop steel forgings up to 4000 lbs. each.
(b) Crankshafts, connecting rods, camshafts, axles, gears, etc.
(c) Complete machining, heat treating.

**Pettibone Mulliken Corp., 4710 W. Division St., Chicago.**
(a) Drop, hammer and upset forgings in alloy and carbon steels, from 1 oz. to 20 lb.
(b) Automotive and railroad parts.
(c) Limited machining and heat treating.

**Phoenix Mfg. Co., Front & Chapel Sts., Catasauqua, Pa.**
(a) Ferrous and non-ferrous drop forgings, up to 20 lb.
(b) Journals, yokes, welding flanges, clevises, also commercial forgings of various types and designs.
(c) Machining facilities.

**Pittsburgh Forgings Co., Coraopolis, Pa.**
(a) Drop and upset forgings, from 1 oz. to 350 lbs.
(b) Automotive, tractor, farm implement, railroad car, machine tool parts, and gear blanks.
(c) Complete heat treating.

**Pittsburgh Forgings Co., Riverside Div., Jackson, Mich.**
(a) Drop forgings, from 3 lbs. to 50 lbs.
(b) Specialty, automotive hubs and tractor wheels.
(c) Complete facilities.

**Pittsburgh Trolley & Forge Co., 117 Water St., Pittsburgh.**
(a) Forgings in carbon and alloy steels, up to 2000 lbs.
(b) Spindles, shafts, gears, rings, etc.
(c) Complete facilities.

**Poor & Co., Canton Forge & Axle Works, 2027 Dueber Ave., S. W., Canton, O.**
(a) Drop die and upset forgings in carbon and alloy steels, from 1 to 350 lbs.
(b) Spindles, levers, gears, etc.
(c) Heat treating facilities.

**Porter Forge & Furnace Inc., 6 Ashland St., Everett, Mass.**
(a) Drop forgings of standard and special steels and metals.
(b) To customers' specifications.
(c) Complete heat treating facilities.

**Portland Forge & Fdry. Co., Portland, Ind.**
(a) Board hammer, upset forgings of steel bars, up to 60 lbs.
(b) Gears, etc.
(c) Complete facilities.

## R

**Revere Copper & Brass Inc., 230 Park Ave., New York.**
(a) Die pressed and hammered forgings, of nonferrous alloys, from fraction of ounce to 19 lbs.
(b) To customers' specifications.
(c) Complete facilities.

**Rhode Island Tool Co., 148 W. River St., Providence, R. I.**
(a) Drop forgings of carbon, alloy and stainless steels, 10 in. dia., 1½ in. thick; 2 in. dia., 18 in. long.
(b) Grippers, wrenches, eyebolts, gear blanks, etc.
(c) Heat treating facilities.

**Rockford Drop Forge Co., 1033 Ninth St., Rockford, Ill.**
(a) Drop forgings.
(b) Automotive and industrial clutches, etc.
(c) Information not available.

**Rome Mfg. Co. Div., Revere Copper & Brass Inc., Railroad St., Rome, N. Y.**
(a) Hot pressed forgings in brass, copper and related alloys.
(b) To customers' specifications.
(c) Complete facilities.

## S

**St. Pierre Chain Corp., 50 Frank St., Worcester, Mass.**
(a) All types of forgings of alloys, soft steels, etc., from 1 oz. to 50 lbs.
(b) Automobile, airplane and other machine parts.
(c) Complete facilities.

**Scovill Mfg. Co., Waterbury, Conn.**
(a) Made-to-order forgings from brass, bronze, copper, and aluminum.
(b) To customers' specifications.
(c) Complete facilities.

**Shuler Axle Co. Inc., 2901 S. Second St., Louisville, Ky.**
(a) All type forgings in carbon and alloy steel, from 1 to 300 lbs.
(b) Automotive and trailer axles, also heavy-duty two-shoe brakes.
(c) Complete facilities.

**Spencer Mfg. Co., Spencer, O.**
(a) Rolled, hammered and upset forgings, in practically any size.
(b) Axle forgings.
(c) Machining and heat treating.

**Spicer Mfg. Corp., Toledo, O.**
(a) Drop, upset and pressure forgings in plain and alloy steels, up to 30 lbs.
(b) Universal joint yokes, forks, gears, shafts, etc.
(c) Complete facilities.

**Steel Improvement & Forge Co., 970 E. 64th St., Cleveland.**
(a) Drop hammer, upset and press forging.
(b) Machine tool, aircraft, automotive, truck and tractor, marine and coal industries.
(c) Complete facilities.

**Storms Drop Forging Co., P. O. Box 2088, Springfield, Mass.**
(a) Drop forgings, from fraction of ounce to 50 lbs., in all grades of forgeable materials; also hot pressed brass forgings.
(b) To customers' specifications.
(c) Complete heat treating.

## T

**Taylor Forge & Pipe Works, P. O. Box 485, Chicago.**
(a) Drop, upset and hammer forgings of carbon and alloy steels, some nonferrous metals, up to 114 in. o.d.
(b) Flanges, rings, nozzles, necks, gear blanks, etc.
(c) Complete facilities.

**Taylor-Wharton Iron & Steel Co., (Easton, Pa. plant), High Bridge, N. J.**
(a) Upset forgings made on 2 in. to 5 in. upsetting machines.
(b) To customers' specifications.
(c) Complete facilities.

**Transue & Williams Steel Forging Corp., Alliance, O.**
(a) All sizes and types of drop forgings from 1 oz. to 1000 lbs. of carbon steels, alloys and nonferrous metals.
(b) Various sizes and types of connecting rods, crankshafts, camshafts, bearing caps, driveshafts and gears.
(c) Complete heat treating.

## U

**Union Forging Co., Endicott, N. Y.**
(a) Drop and press forgings.
(b) Automotive parts.
(c) Heat treating facilities.

## V

**Vulcan Steam Forging Co., 223-257 Rano St., Buffalo, N. Y.**
(a) Open die forgings of carbon, alloy, tool and stainless steels, and nonferrous metals.
(b) Gear blanks, crankshafts, piston rods, levers, spindles, rolls, weldless rings, shaped work.
(c) Complete facilities.

## W

**Wilcox Mfg. Co., The D., N. Chestnut and E. Allen Sts., Mechanicsburg, Pa.**
(a) Drop forgings of alloy and carbon steel, 1 oz. to 30 lbs.
(b) To customers' specifications.

**Williams, J. H., & Co., 400 Vulcan St., Buffalo, N. Y.**
(a) Drop forgings in steel and nonferrous metal from ½ oz. to 100 lbs.
(b) Structural forged parts, gears, levers, cams, cranks, etc., for machine tools, gas engines, compressors, aircraft, automotive, etc.
(c) Complete facilities.

**Wyman-Gordon Co., Worcester, Mass., and Harvey, Ill.**
(a) Drop hammer, unset and press forgings in steel and aluminum from 10 to 500 lbs.
(b) Automotive and aviation.
(c) Heat treating facilities.

# STAMPINGS

AIRCRAFT PRECISION

**WORCESTER PRESSED STEEL CO.**

WORCESTER, MASSACHUSETTS

*You can specify "PRESTEEL" with confidence*



# WHAT FELT

would you specify here?

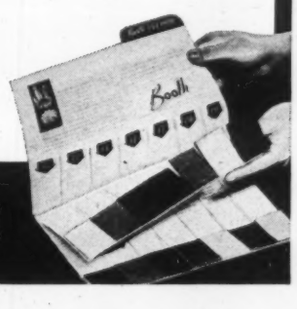
**LOOK BELOW FOR YOUR ANSWER**

The BOOTH mechanical felt part in this aircraft application illustrates one of many felt uses . . . classified authoritatively in the valuable reference work pictured below Can felt be profitably used? What type of felt? These questions are constantly before Design, Production and Purchasing executives. The Booth chart answers them. BOOTH FELT COMPANY, 444 19th Street, Brooklyn, New York, 734 Sherman Street, Chicago, Ill.

**COMBINATION FELT APPLICATION CHART AND SAMPLE FILE-FOLDER**

Of standard file size, it contains actual swatches of the 14 S.A.E. felt types, together with complete reference and specification tables. Write for your copy No obligation . . . no sales follow-up.

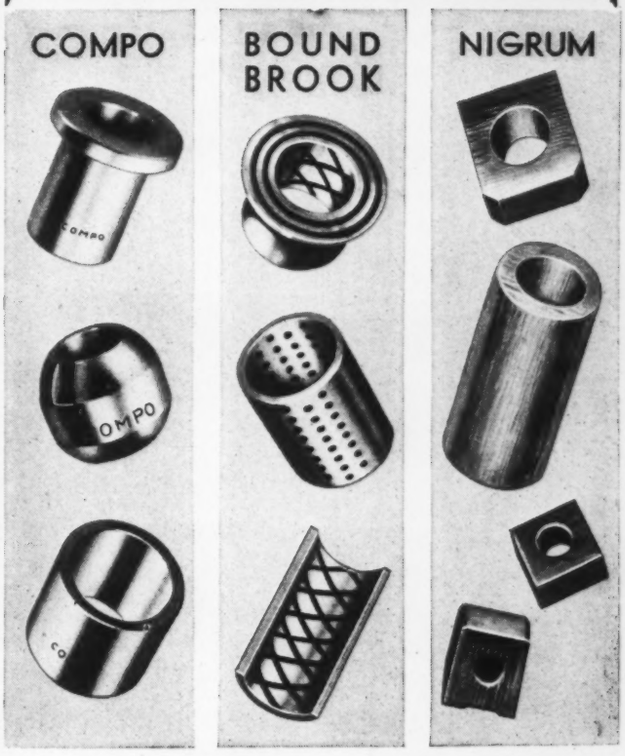
1635



Booth



FOR BETTER MACHINES AND APPLIANCES




# *The* Big-Three

● COMPO Oil-Retaining Porous Bronze Bearings contain up to 35% of lubricant; made by die-pressing pure metal powders, alloying at high temperatures and finishing to great accuracy; used on thousands of applications.

● BOUND BROOK Cast Phosphor Bronze Bearings, inlaid with enduring graphite lubricant, in grooves or holes of various designs; fine for inaccessible installations.

● NIGRUM Impregnated Hardwood Bearings, made of selected northern hard maple and completely filled with a special lubricant; quiet, trouble-proof and efficient.

## Now . . . Compo Bearings for Immediate Shipment

Every designing engineer and purchasing agent should have a copy of this time-saving Stock List. It contains hundreds of sizes, dimensions and prices on Plain and Flanged Bearings and Thrust Washers, in Stock for Immediate Shipment, together with valuable bearing data helpful in solving difficult bearing problems. Also ask for Bulletin on any of the "Big-Three" Bearings.

The Bound Brook Engineering Service Department and Testing Laboratory, with a vast library of Bearing Application Data, invites correspondence with Designing and Production Engineers, particularly on problems of remote or inaccessible bearings.

**BOUND BROOK OIL-LESS BEARING CO.**

(Est. 1883) Main Office and Plant: BOUND BROOK, NEW JERSEY
Sales and Service: DETROIT, MICHIGAN and LOS ANGELES, CAL.

FOR BETTER MACHINES AND APPLIANCES

# Die Castings Producers

*Reference letters beneath addresses of companies refer to: (a) Types, materials and sizes of die castings; (b) Names of die-cast parts customarily produced; and (c) Machining, finishing and assembling facilities.*

## A

**American Magnesium Corp., 2210 Harvard Ave., Cleveland.**
(a) Low and high pressure die castings of various magnesium alloys, in any size.
(b) To customers' specifications.
(c) Light machining.
*See advertisement, Page 69-D*

**Aurora Metal Co., 614 W. Park Ave., Aurora, Ill.**
(a) Aluminum bronze and silicon bronze die castings.
(b) Variety of machine parts.
(c) Complete facilities.

## C

**Cincinnati Die Casting Co., 2121 Spring Grove Ave., Cincinnati.**
(a) From small to very large zinc base, high-tensile aluminum and magnesium alloy die castings.
(b) Automotive, radio, mechanical, etc.
(c) Complete facilities.

**Cleveland Hardware & Forging Co., 4518 Lakeside Ave., Cleveland.**
(a) Aluminum and zinc from minute to 12½ lbs.
(b) Automotive, musical machines, vacuum cleaners, sewing machines, motors and domestic appliances.
(c) Complete facilities.

**Congress Die Casting Div., 3750 E. Outer Drive, Detroit.**
(a) Zinc alloy die castings, to 10 lbs.
(b) Pulleys, flexible couplings, vending machine, washing machine, radio, woodworking machine and automotive parts.
(c) Complete facilities.

## D

**Dayton Die Casting Co., 303 Keowee St., Dayton, O.**
(a) Zinc alloy, lead and tin die castings.
(b) To customers' specifications.

**Doehler Die Casting Co., Toledo, O. (Other plants at Batavia, N. Y., and Pottstown, Pa.)**
(a) Zinc, aluminum, brass, bronze, tin, lead and magnesium die castings.
(b) All types of machine parts.
(c) Machining and finishing facilities.

**Dollin Corp., 610 S. 21st St., Irvington, N. J.**
(a) All sizes, in aluminum and zinc.
(b) All types of machine parts.
(c) Machining and trimming facilities.

**Dow Chemical Co., The, Midland, Mich.**
(a) Dowmetal, magnesium alloy, die castings.
(b) All types of automotive, aircraft and other machine parts.
(c) None.
*See advertisement, Page 3-D*

## F

**Federal-Mogul Corp., 11031 Shoemaker Ave., Detroit.**
(a) Tin and lead base, medium and small die castings.
(b) Primarily bearings and bushings.
(c) Complete facilities.

## H

**Hoover Co., The, Maple and McKinley Sts., North Canton, O.**
(a) Aluminum and zinc die castings, to 24 in. square.
(b) To customers' specifications.
(c) Complete facilities.

## M

**Madison-Kipp Corp., 210 Waubesa St., Madison, Wis.**
(a) Zinc, aluminum, magnesium, and brass die castings, all sizes.
(b) Automotive, household appliance, railway, ordnance parts, etc.
(c) Complete facilities.
*See advertisement, Page 8-D*

**McGill Mfg. Co., Metal Div., Valparaiso, Ind.**
(a) Aluminum, bronze and special hard bronze die castings, from ½ oz. to 10 lbs. Hydraulic pressure castings of hard yellow brass and silicon bronze, ½ oz. to 2 lbs.
(b) Great variety of machine parts including gears, levers, and other corrosion resistant machine parts.
(c) Complete facilities.

**Milwaukee Die Casting Co., 1015 N. Fourth St., Milwaukee.**
(a) Zinc to 5 lbs.; lead, tin to 14 lbs.
(b) Motor cases, electrical apparatus, business machine, washing machine, etc.
(c) Machining and finishing facilities.

## N

**National Lock Co., 1902 Seventh St., Rockford, Ill.**
(a) Zinc die castings to 12 in.
(b) To customers' specifications.
(c) Complete facilities.

**Newton-New Haven Co., 683 Third Ave., West Haven, Conn.**
(a) Zinc base and high pressure aluminum die castings to 3 lbs.
(b) Aviation parts.
(c) Finishing facilities only.

## P

**Paragon Die Casting Co., 5851 W. Dickens Ave., Chicago.**
(a) Zinc and aluminum die castings.
(b) Auto, radio, refrigerator, food mixer, washing machine, etc.
(c) Machining and plating facilities.

**Parker White Metal & Machine Co., McKinley Ave., at 23rd St., Erie, Pa.**
(a) Zinc and aluminum base die castings in any size.
(b) All types of machine parts.
(c) Complete facilities.

**Precision Castings Co. Inc., Fayetteville, N. Y. (Branch, Cleveland, O.; Die Shop, Syracuse, N. Y.)**
(a) Aluminum and zinc castings from fraction of ounce to 26 lbs.
(b) Automotive, household appliances, outboard motors, etc.
(c) Machining, assembling facilities.

**Precision Castings Co. Inc., Syracuse, N. Y. (also Cleveland).**
(a) Zinc and aluminum die castings, large or small.
(b) To customers' specifications.
(c) Machining and finishing facilities.

**Pressure Castings Inc., 21500 St. Clair Ave., Cleveland.**
(a) Zinc and aluminum alloy die castings to 24 x 24 in.
(b) To customers' specifications.
(c) Finishing and machining facilities.

## S

**Schultz Die Casting Co., 1810 Clinton St., Toledo, O.**
(a) Zinc base die castings.
(b) Automotive, etc.
(c) Machining and finishing facilities.

**Stewart Die Casting Div., Stewart-Warner Corp., 4535 Fullerton Ave., Chicago.**
(a) Zinc and aluminum castings to 20 lbs.
(b) To customers' specifications.
(c) Finishing facilities.

**Superior Die Casting Co., 17325 Euclid Ave., Cleveland.**
(a) Zinc and aluminum alloy die castings.
(b) Ordnance, aircraft and various machine parts.
(c) Information not available.

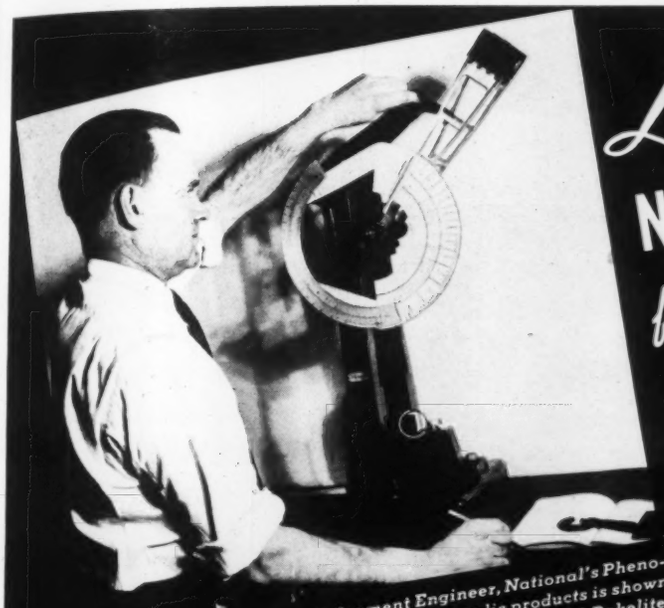
## T

**Titan Metal Mfg. Co., Bellefonte, Pa.**
(a) Brass and bronze; up to 2 lbs.
(b) Electrical, refrigeration, and miscellaneous parts up to 20 lbs.
(c) Machining and assembling.

**Toman, E., & Co., 2621 W. 21st place, Chicago.**
(a) All types of zinc base die castings from ½ oz. to 8 lbs.
(b) To customers' specifications.
(c) Complete facilities.

## U

**Universal Bearing Co., 639 Broadway, Lorain, O.**
(a) Universal bearing metal die castings.
(b) Bearings.
(c) Information not available.



Gerald H. Mains, Chief Development Engineer, National's Phenolite Plant, credited with 15 patents on phenolic products is shown making Impact Strength Tests on Phenolite, laminated Bakelite.

Look to NATIONAL ENGINEERS for Real Help in Selecting the Right LAMINATED PRODUCTS

★ National's Engineering Data, covering product design problems in practically every industry, plus National's long-experienced research men, enable us to offer you valuable help in design and production problems through the use of Vulcanized Fibre and Phenolite, laminated Bakelite. (Both obtainable in sheets, rods, tubes and special shapes.) You can save time and trouble by taking advantage of the research facilities we offer you. There's no obligation. Write us today.

PHENOLITE Laminated BAKELITE

NATIONAL VULCANIZED FIBRE

PEERLESS INSULATION

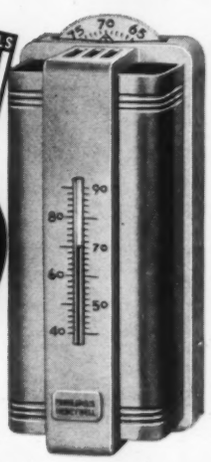
NATIONAL VULCANIZED FIBRE CO.

Offices in Principal Cities

Wilmington, Delaware

"CHACE HIGH-TEMPERATURE Thermostatic BIMETAL IS USED IN THE TYPE 81 ACRATHERMS Snap Action THERMOSTATS"

AUTOMATIC CONTROLS MH



Minneapolis-Honeywell Regulator Co., Minneapolis

THESE thermostats are snap action, open contact devices, designed for low voltage control circuits. Chace High-Temperature Thermostatic Bimetal was chosen for the active element in these thermostats.

If you make a product that calls for automatic movement at a set temperature, or if you must control temperature, then some one of the various types of Chace Thermostatic Bimetal will exactly meet your demands. Sold in sheets, strips, and in fabricated parts, ready for your assembly.

W. M. CHACE CO.

1616 Beard Avenue - - - Detroit Mich.

BASKETS for ANNEALING DIPPING CONVEYING

"Buffalo" Wire Baskets are extra sturdy, made for long, hard use on *your* job. Longer life makes their cost small. Available in standard or special alloy metals.

Submit your basket problem and let us suggest a construction that will save you money.

A simple change in design can double the life of a basket. You cannot save except with good design.

Write for Catalog 10-N

MADE BY THE MANUFACTURERS OF INDUSTRY'S FINEST WIRE CLOTH

4

BUFFALO WIRE WORKS CO., Inc.

ESTABLISHED 1869 AS SCHEELER'S SONS

430 TERRACE BUFFALO, N. Y.

# Custom Molders of Plastics

*Reference letters beneath addresses of companies refer to: (a) Types of materials utilized; and (b) Names of machine parts customarily molded.*

## A

**Ackerman Plastic Molding Co., 986 E. 200th St., Cleveland.**
(a) BAKELITE, DUREZ, BEETLE, PLASKON, TENITE, THIOKOL.
(b) Mechanical, electrical and industrial.

**American Insulator Corp., New Freedom, Pa.**
(a) BAKELITE, DUREZ, PLASKON, BEETLE, LUMARITH, TENITE, PLASTACELE, LUCITE and cold-molded composition.
(b) To customer's specifications.

**American Molding Co., 16th and Vermont Streets, San Francisco.**
(a) BAKELITE, DUREZ, BEETLE, PLASKON, TENITE, LUMARITH, RESINOX, FIBESTOS, CRYSTALITE, PLASTACELE, LUCITE, POLYSTYRENE.
(b) Technical, automotive, etc.

**American Phenolic Corp., 1250 W. Van Buren St., Chicago.**
(a) BAKELITE, DUREZ, AMPHENOL, SUNEX, transparent POLYSTYRENE.
(b) Electrical small sections, special rods and tubes.

**American Products Mfg. Co., 8127-33 Oleander St., New Orleans.**
(a) TENITE, PLASTACELE, INCELOID and LUMARITH.
(b) Miscellaneous small parts not exceeding 4 oz.

**Armstrong Cork Co., Industrial Div., Lancaster, Pa.**
(a) CORPRENE.
(b) Gaskets, valve disks, cup packings, bushings, rolls, strips, sheets, etc.
*See advertisement, Page 89-D*

**Atlantic Plastics, 2730 Grand Ave., Cleveland.**
(a) BAKELITE, BEETLE, PLASKON, DUREZ, RESINOX, TENITE, LUCITE, PLASTACELE, LUMARITH, THIOKOL and other synthetics.
(b) Safety supply parts, lighting and electrical, radio, chemical, mechanical, etc.

**Auburn Button Works Inc., Auburn, N. Y.**
(a) BAKELITE, DUREZ, RESINOX, BEETLE, PLASKON, TENITE, LUCITE.
(b) All types of machine parts.

## B

**Berkander Inc., George F., 891 Broad St., Providence, R. I.**
(a) TENITE, LUMARITH, PLASTACELE.
(b) To customers' specifications.

**Boonton Molding Co., 326 Myrtle Ave., Boonton, N. J.**
(a) BAKELITE, DUREZ, RESINOX, TENITE, PLASTACELE, LUCITE, CRYSTALITE, STYRON, POLYSTYRENE, PLASKON, BEETLE.
(b) To customers' specifications.

**Butterfield Inc., T. F., 56 Rubber Ave., Naugatuck, Conn.**
(a) BAKELITE, DUREZ, MAKALOT, BEETLE, PLASKON, TENITE, LUMARITH, LUCITE, etc.
(b) Radio, heater switch, electrical, etc.

## C

**Chicago Die Mold Mfg. Co., 1735 W. Diversey Parkway, Chicago.**
(a) TENITE, BAKELITE, PLASKON, LUCITE, STYRON, etc.
(b) To customers' specifications.

**Chicago Molded Products Corp., 1028 N. Kolmar Ave., Chicago.**
(a) BAKELITE, DUREZ, RESINOX, PLASKON, BEETLE, TENITE, LUMARITH, PLASTACELE, LUCITE, POLYSTYRENE.
(b) Automotive, industrial, mechanical, scientific, surgical, electrical.
*See advertisement Page 89-D*

**Cincinnati Advertising Products Co., Plastics Div., 400 Pike St., Cincinnati.**
**(a) PLASTACELE, TENITE, LUMARITH, LUCITE, CRYSTALLITE, LUSTRON, POLYSTYRENE and VINYLITE.**
(b) All types of injection molded machine parts.

**Cleveland Plastics Inc., 12910 Taft Ave., Cleveland.**
(a) BAKELITE, BEETLE, CRYSTALITE, DUREZ, ETHOCEL, LUCITE, LUMARITH, MONSANTO, PLASKON, PLASTACELE, RESINOX, STYRON, TENITE.
(b) To customers' specifications.

**Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.**
(a) All plastic materials.
(b) All types of machine parts.

**Columbus Plastic Products Inc., 519 Dublin Ave., Columbus, O.**
(a) TENITE, LUMARITH, PLASTACELE, POLYSTYRENE, LUCITE, CRYSTALITE and VINYLITE.
(b) Insulator parts, control knobs, wheels, small housings, etc.

**Connecticut Plastic Products Co., 124 N. Elm St., Waterbury, Conn.**
(a) TENITE, LUMARITH, PLASTACELE, BAKELITE-Acetate, LUCITE, POLYSTYRENE, CRYSTALITE, and other thermoplastic materials.
(b) Business machine parts, camera cases, etc.

**Continental-Diamond Fibre Co., Newark, Del.**
(a) CELORON, DILECTO.
(b) Gears, couplings, aircraft parts, etc.

**Cutler-Hammer Inc., 315 N. 12th St., Milwaukee.**
(a) THERMOPLAX, PYROPLAX.
(b) Terminal blocks, insulators, switch bases, knobs, handles, insulating bushings, arc shields and miscellaneous electrical insulating forms.

## D, E

**Diemolding Corp., Canastota, N. Y.**
(a) BAKELITE, DUREZ, PLASKON, BEETLE, TENITE or any other plastics of similar nature.
(b) Control handles or knobs, small bases and plates, housings, etc.

**Eclipse Moulded Products Co., Milwaukee.**
(a) BAKELITE, DUREZ, PLASKON, BEETLE, LUMARITH, LUCITE, TENITE, RESINOX.
(b) All types of compression moldings.

**ERIE RESISTOR CORP., 644 W. 12th St., Erie, Pa.**
(a) All extrusion and injection molding materials.
(b) Aircraft, automobile, radio, refrigerator parts, three dimensional knobs, bezels, etc.; also plastic molded around glass for instrument faces.

## F, G

**Firestone Rubber & Latex Products Co., Fall River, Mass.**
(a) All compression and injection molding materials.
(b) Lenses, plastics over metal, refrigerator trim, cabinets and housings, electrical parts, etc.

**Franklin Plastic & Die Casting Div., Baldwin Laboratories Inc., Franklin, Penna.**
(a) All types of materials.
(b) Automotive, refrigerator, radio, etc.

**General Electric Co., Plastics Dept., 1 Plastics Ave., Pittsfield, Mass.**
(a) TEXTOLITE (molded, laminated and cold-molded).
(b) All types to customers' requirements.
*See advertisement, Page 67-D*

**General Industries Co., International Insulating Div., Elyria, O.**
(a) BAKELITE, DUREZ, RESINOX, PLASKON, BEETLE, TENITE, LUMARITH, PLASTACELE, LUCITE, CRYSTALITE.
(b) Special parts to customers' specifications.

**Gits Molding Corp., 4600 W. Huron St., Chicago.**
**(a) TENITE, LUMARITH, PLASTACELE, LUCITE, POLYSTYRENE.**
(b) Radio knobs and cabinets, push-buttons, escutcheons, dials, supports and insulators.

**Globe Tool & Molded Products Co., 1032 Mulberry St., Rockford, Ill.**
**(a) BAKELITE, MAKALOT, DUREZ, RESINOX, BEETLE, PLASKON, TENITE, LUCITE and POLYSTYRENE.**
(b) To customers' specifications.

## H, I

**Haveg Corp., Newark, Del.**
(a) HAVEG.
(b) Acid-resistant equipment, standard tanks, piping, fittings, fume duct, towers, etc.

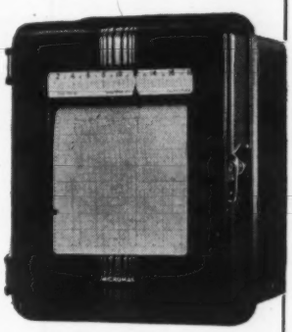
**Insulation Products Co., 504 North Richland St., Pittsburgh.**
(a) BAKELITE, DUREZ, TENITE, PLASKON.
(b) Parts to customers' specifications.

**International Molded Plastics Inc., 4384 West 35th St., Cleveland.**
(a) BAKELITE, DUREZ, TENITE, VINYLITE, LUCITE, and POLYSTYRENE.
(b) To customer's specifications.

## K

**Keolyn Plastics Co., 2731 N. Pulaski Rd., Chicago.**
(a) PLASTACELE, TENITE, LUCITE, POLYSTYRENE, LUMARITH and other thermoplastics for injection molding. Fully

# ALWAYS WORKING ...but never weary



In helping to meet today's commercial and defense demands, many a Leeds & Northrup "Micromax" Recorder is denied all holidays—works 24 hours to a shift, 7 days a week. For such constant service, Leeds & Northrup demands electrical contacts of high accuracy. And *gets* them—in Wilco materials. And just as Wilco meets these exacting requirements for electrical contacts—so do Wilco's Thermometals (thermostatic bimetals) provide dependability for temperature control —or reaction from temperature changes.

Whether your orders are large or small, they are personally supervised by an executive of The H. A. Wilson Co. And that means shipments that are *right*—every time! For full information, write: The H. A. Wilson Co., 105 Chestnut St., Newark, N. J. *Branches:* Chicago and Detroit.

*Now more than ever Personal Attention Counts*

WILCO THE H. A. WILSON CO.

# INDIUM FOR

*Decorative Design* provides a permanent, continuous surface capable of high polish, resistant to discoloration. . . .

**Functional Design** provides a hard, nonporous surface resistant to wear, abrasion, corrosion and fatigue. . . .

*Write today for complete information: how* INDIUM *can solve your design or construction problem.*

**THE INDIUM CORPORATION OF AMERICA**

Research and Development Office 60 East 42nd Street N Y C

Sales Office and Laboratory 805 Watson Place, Utica, N. Y

# 10 OF THE VITAL SERVICES CUT FELT PARTS are performing in industry

1. as seals to prevent oil leaks;
2. as oil washers acting as oil reservoirs to adjacent bearings;
3. for dust and mud exclusion;
4. as wicks used as a lubricating medium for bearings;
5. as daubers to place grease on sheets;
6. as wipers to scrape grease or chemicals from metal sheets;
7. to polish metals, glass and plastics;
8. as vibration dampeners;
9. as sound deadeners;
10. for insulation against heat or cold.

**Cut Felt Parts are vital factors in the efficient and economical operation of practically all forms of machines. In the nationwide drive for greater production the importance of Cut Felt Parts is being more fully recognized. Helpful, factual Data Sheets are available, and capable Sales Engineers will be glad to consult with you when you are setting up your blueprints.**

***For best results, buy quality!***

**American Felt Company** TRADE MARK

*General Offices:* GLENVILLE, CONN.

Plants at Glenville, Conn., Newburgh, N. Y. Franklin, Mass., City Mills, Mass., Detroit, Mich.
Sales Offices at New York—Boston—Chicago—Philadelphia Cleveland—Detroit—St. Louis—San Francisco

equipped to fabricate cast plastics by machining.
(b) Knobs, handles, housings and special parts.

**Keystone Specialty Co., 1373½ Cove Ave., Lakewood, O.**
(a) Any plastic material to customers' specifications.
(b) Parts to customers' specifications.

**Kuhn & Jacob Moulding & Tool Co., 1200 Southard St., Trenton, N. J.**
(a) BAKELITE, DUREZ, BEETLE, PLASKON, TENITE, LUCITE, LUMARITH, etc.
(b) Compression molding of electrical, automotive, radio, airplane, instrument, permanent wave machine parts, etc.; also any type of injection molding.

**Kurz-Kasch Inc., 1415 S. Broadway, Dayton, O.**
(a) BAKELITE, DUREZ, BEETLE, PLASKON, LUMARITH, TENITE, CRYSTALITE, LUCITE.
(b) Shift balls, general insulating parts, both mechanical and electrical.

## M

**Mack Molding Co. Inc., Ryerson Ave., Wayne, N. J.**
(a) BAKELITE, DUREZ, TENITE, BEETLE, LUMARITH, FIBESTOS, PLASKON.
(b) Parts to customers' specifications.

**Martindell Molding Co., N. Olden at Sixth, Trenton, N. J.**
(a) Cellulose acetate, phenolics and urea.
(b) To customer's specifications.

**Mason Co. Inc., The Thomas, Sunnyside Ave., Stamford, Conn.**
(a) BAKELITE (all types), TENITE, LUCITE, CRYSTALLITE, etc.
(b) Aircraft control parts, including brackets, spacers, rollers, pulleys, housings, etc.

**Metal Specialty Co., 814 South L St., Richmond, Ind.**
(a) ETHOCEL, TENITE, CRYSTALITE, LUCITE, POLYSTYRENE, LUMARITH, NIXONITE, etc.
(b) Automobile, radio and refrigerator parts.

**Michigan Molded Plastics Inc., G and Baker Sts., Dexter, Mich.**
(a) BAKELITE, DUREZ, TENITE, PLASTACELE, LUMARITH, PLASKON, LUCITE.
(b) Molded plastic parts, all types and sizes by compression, injection and extrusion.

**Molded Insulation Co., 335 E. Price St., Philadelphia.**
(a) BAKELITE, DUREZ, RESINOX, DURITE, BEETLE, PLASKON, TENITE, LUCITE.
(b) Aircraft, radio, electrical and other machine parts and assemblies.

## N

**National Lock Co., Rockford, Ill.**
(a) BAKELITE, BEETLE, PLASKON, DUREZ, TENITE.
(b) Handles, pulls, stove and refrigerator trim.

**Niagara Insul Bake Specialty Co. Inc., 482 Delaware Ave., Albany, N. Y.**
(a) BAKELITE, DUREZ, RESINOX, MAKALOT, PLASKON, BEETLE, LUCITE, TENITE, LUMARITH, and CRYSTALLITE.
(b) Air dash pots, etc.

**Northern Industrial Chemical Co., 7 Elkins St., South Boston, Mass.**
(a) BAKELITE, DUREZ, BEETLE, PLASKON, TENITE, LUMARITH, etc.
(b) Any molded part to customers' specifications.

**Northwest Plastics Inc., 2233 University Ave., St. Paul, Minn.**
(a) BAKELITE, INDUR, DUREZ, MAKALOT, LUCITE, RESINOX, BEETLE, and PLASKON.
(b) Industrial parts of all types.

**Norton Laboratories Inc., 520 Mill St., Lockport, N. Y.**
(a) BAKELITE, DUREZ, PLASKON, BEETLE, TENITE, LUMARITH, LUCITE, CRYSTALITE, PLASTACELE.
(b) Housings, terminals, bushings, wheels, knobs, handles, etc.

## P

**Peerless Molded Plastics Inc., 401 Hamilton St., Toledo, O.**
(a) DUREZ, RESINOX, BAKELITE, TENITE, LUMARITH, LUCITE, and PLEXIGLAS.
(b) Electrical, mechanical, radio, automotive, camera, etc.

**Pierce Plastics Inc., 116 First St., Bay City, Mich.**
(a) TENITE, SARAN, LUSTRON, VINYLITE, LUMARITH, PLASTACELE, ETHOCEL, CRYSTALLITE, LUCITE, and KOROSEAL.
(b) Electrical, trim, etc.

**Plastic Molding Corp., Sandy Hook, Conn.**
(a) BAKELITE, DUREZ, MAKALOT, RESINOX, BEETLE, and PLASKON.
(b) Handles, insulators, electrical device parts, bases, cases, etc.

**Plastics Inc., 813 Main St., Avon, N. J.**
(a) BAKELITE, TENITE, LUCITE, LUMARITH and PLASTACELE.
(b) Parts for refrigerators, vacuum cleaner housings, automotive panel parts, horn button assemblies, radio and electrical parts, housings, etc.

**Pyro Plastics Co., The, 526-532 North Ave. East, Westfield, N. J.**
(a) TENITE, PLASTACELE, LUMARITH, FIBESTOS, POLYSTYRENE, LUCITE, CRYSTALITE.
(b) To customers' specifications.

## R

**Recto Molded Products Inc., Appleton and B. & O. R. R., Oakley, Cincinnati.**
(a) DUREZ, BAKELITE, TENITE, LUMARITH, RESINOX, PLASKON.
(b) All types to customers' specifications.

**Reinhold, F. E., 7001 McKinley Ave., Los Angeles.**
(a) BAKELITE, BEETLE, DUREZ, and RESINOX.
(b) Electrical parts, radio cabinets, etc.

**Reynolds, Molded Plastics Div., Reynolds Spring Co., Cambridge, O.**
(a) BAKELITE, PLASKON, TENITE, LUMARITH, BEETLE, DUREZ, LUCITE.
(b) All types to customers' specifications.

**Richardson Co., The, 27th and Lake Sts., Melrose Park, Chicago.**
(a) INSUROK, EBROK, RUB-TEX, RUBEROK, MICAROK.
(b) All types to customer's specifications.
*See advertisement, Page 24-D*

**Royal Moulding Co., 69 Gordon Ave., Providence, R. I.**
(a) BAKELITE, RESINOX, DUREZ, PLASKON, BEETLE, MAKALOT.
(b) Electrical appliance housings.

## S

**Sinko Tool & Mfg. Co., 351 N. Crawford Ave., Chicago.**
(a) TENITE Nos. 1 and 2, POLYSTYRENE. LUMARITH, PLASTACELE, FIBRELOID, LUCITE, CRYSTALITE, also metal reinforced thermoplastics.
(b) Radio and automotive knobs, pushbuttons, escutcheons, bezels, etc.

**Specialty Insulation Mfg. Co. Inc., Hoosick Falls, N. Y.**
(a) COLASTA, BAKELITE, DUREZ, TENITE, BEETLE, PLASKON, etc.
(b) Business machines parts, etc.

**Sterling Plastics Co., 6 Garden St., Newark, N. J.**
(a) LUCITE, TENITE, LUMARITH, POLYSTYRENE, and CRYSTALLITE.
(b) Knobs, cigarette vending machine parts, nameplates, etc.

**Stokes Rubber Co., Jos., Taylor and Webster Sts., Trenton, N. J.**
(a) All types of thermosetting and thermoplastic materials.
(b) Parts made by compression or injection molding.

**Stricker-Brunhaber Corp., 19 W. 24th St., New York.**
(a) BAKELITE, CATALIN, TENITE, and rubber, wood and transparent plastics.
(b) Injection and compression molded, mechanical and experimental models.

**Superior Plastic Co., 643 North Kedzie Ave., Chicago.**
(a) TENITE, LUMARITH, ETHOCEL, PLASTACELE, LUCITE and POLYSTYRENE.
(b) To customer's specifications.

**Synthetic Moulded Products Inc., Wakefield, R. I.**
(a) BEETLE, PLASKON, BAKELITE, DUREZ and other acetates.
(b) Marine, aircraft, textile machinery parts.

## T, V

**Tech Art Plastics Co., 41-01—36th Ave., Long Island City, N. Y.**
(a) MAKALOT, BAKELITE, DUREZ, LUCITE, PLEXIGLAS, POLYSTYRENE and acetates.
(b) Precision molded parts for electrical equipment and instruments.

**Ther Electric & Machine Works, 17 S. Jefferson St., Chicago.**
(a) DUREZ, BAKELITE, PLASKON, etc.
(b) To customers' specifications.

**Universal Plastics Corp., 235 Jersey Ave., New Brunswick, N. J.**
(a) All materials which can be compression and injection molded.
(b) To customer's specification.

**Van Norman Molding Co., 6437, S. State St., Chicago.**
(a) BAKELITE, DUREZ, PLASKON.
(b) Knobs, handles and electrical meter cases.

## W

**Ward Plastic & Rubber Co., 1037 Hilton Rd., Ferndale, Mich.**
(a) All thermoplastic and thermosetting materials.
(b) Condulet boxes, coil bobbins, bearings handles, oil seals, pump parts such as washers, seals, stators, various electrical parts, etc.

**Warren Plastics Corp., Warren, Pa.**
(a) BAKELITE, DUREZ, RESINOX, BEETLE, PLASKON, MASURON.
(b) Small machine parts.

**Waterbury Button Co., The, 39 River St., Waterbury, Conn.**
(a) BAKELITE, DUREZ, BEETLE, PLASKON, TENITE, LUCITE, SHELLAC COMPOSITION, LUMARITH, RESINOX, CRYSTALITE, POLYSTYRENE, etc.
(b) All types to customers' specifications.

**Watertown Mfg. Co., 138 Echo Lake Rd., Watertown, Conn.**
(a) NEILLITE, BAKELITE, DUREZ, RESINOX, TENITE, LUMARITH, FIBESTOS, PLASTACELE, LUCITE, BEETLE, PLASKON.
(b) Contact blocks, insulator blocks, switch housings, cams, spacers, radio cabinets, cases and any other moldable parts.

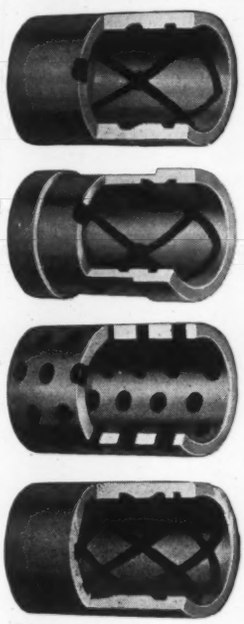
**Werner Co. Inc., R. D., 389 Second Ave., New York.**
(a) TENITE, LUMARITH and all other thermoplastic materials.
(b) Trim, etc.

**Westinghouse Electric & Mfg. Co., Trafford, Pa.**
(a) MICARTA.
(b) To customers' specifications.

**White Dental Mfg. Co., The S. S., Plastics Dept., 10 E. 40th St., New York.**
(a) TENITE LUMARITH, LUCITE, CRYSTALITE, POLYSTYRENE.
(b) Automotive, electrical, etc.

**Windman Brothers, 3325 Union Pacific Ave., Los Angeles.**
(a) BAKELITE, DUREZ, PLASKON, BEETLE, all phenolics and ureas; Styrenes, acrylic resins and TENITE or cellulose acetates.
(b) Electric razor cases, radio cabinets, electrical, mechanical, dental, photographic and surgical equipment parts.

## Hundreds of thousands of RANDALL BEARINGS are mobilized for defense



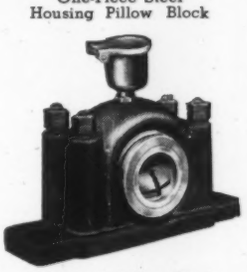
Cut-away sections of a few of many styles of Randall Bushings

★ All over America . . . under every condition Randall Bushings guard your equipment against bearing failure. Rely on them for consistently *quiet, trouble-free, low-cost* operation. Machined grooves permanently filled with porous lubricating graphite provide, and also retain, lubrication. They act as capillary wicks when used in connection with oil reservoirs, and provide controlled, proper and efficient lubrication to the shaft.

## Randall self-aligning self-lubricating Pillow Blocks . . .

★ Always on duty, Randall Pillow Blocks are a modern home-front defense against bearing troubles . . . your assurance of a quiet, economical lifetime of trouble-free service.

One-Piece Steel Housing Pillow Block



Universal Pillow Block

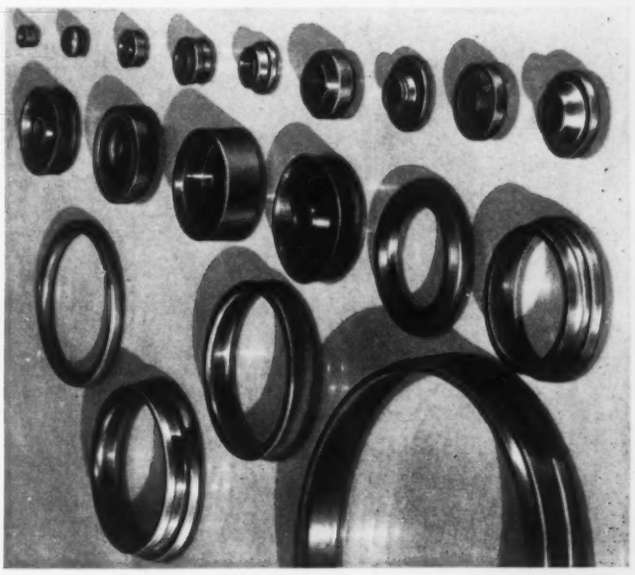
★ *Write today for helpful, free catalogs of bushings and pillow blocks*

**RANDALL GRAPHITE PRODUCTS CORP.**
**Dept. 1017 — 609 W. Lake Street — Chicago, Ill.**

# PRECISION

*To Meet Every Requirement of*

# Machine Design



# MOLDED SYNTHETIC RUBBER

- *WASHERS*
- *GASKETS*
- *PACKINGS*
- *DIAPHRAGMS*
- *SHEET STOCK*

**NEOPRENE • PERBUNAN • HYCAR • THIOKOL**

## Acadia Synthetic Products

***DIVISION WESTERN FELT WORKS***

**4037-4117 Ogden Avenue • Chicago, Illinois**

*Largest Independent Manufacturers and Cutters of Wool, Hair and Jute Felts. Established 1899.*

**BRANCH OFFICES IN ALL PRINCIPAL CITIES**

# Machine Finishes Producers

*Reference letters beneath addresses of companies refer to: (a) Trade-name and type of finish, availability in color; (b) Method of application and drying; and (c) Characteristics and use of finish.*

## A

**Akron Paint & Varnish Co., Firestone Parkway, Akron, O.**
(a) Enamel in all colors.
(b) For brushing and spraying; air drying and baking.
(c) Decorative and rustproofing; heavy machinery.

**Alrose Chemical Co., P. O. Box 1294, Providence, R. I.**
(a) JETAL, for obtaining black finish on ferrous metals.
(b) Chemical oxidation by immersion.
(c) Decorative, rustproofing, heat resisting; for machines, appliances.

**Aluminum Co. of America, Gulf Bldg., Pittsburgh.**
(a) ALROK (aluminum oxide) colorless, bluish or greenish grey, dyed colors.
(b) Chemical.
(c) Corrosion resistant; applied to aluminum parts for protection or as surface preparation for paint.

**American Chemical Paint Co., Ambler, Pa.**
(a) THERMOIL GRANODINE phosphate coating chemical; KEMICK chemical paint; available in Matte gray.
(b) For hot dipping, and drying by compressed air, etc.
(c) Wear, rust and heat resistant; for use on automobile engine parts, gears, bearing surfaces, etc.

**Apollo Metal Works, 6605 S. Oak Park Ave., Chicago.**
(a) APOLLO pre-chromed metal, in bright and satin chrome and satin striped patterns.
(b) Plating.
(c) For decorative purposes on dry-cleaning machines, automatic toasters, electric heaters, etc.; is heat and rust resistant.

**Arco Co., The, 7301 Bessemer, Cleveland.**
(a) ARCO lacquers, synthetics and oil enamels; available in standard machine tool gray or special shades.
(b) Adaptable for any application method; air or force dried.
(c) Rust, heat and oil resistant; for all industrial machinery.

**Ault & Wiborg Corp., 75 Varick St., New York.**
(a) POLYMERIN speed-bake enamel, WRINKLE enamel, and AULTONE lacquers; available in all colors.
(b) POLYMERIN and WRINKLE for spraying and dipping, and baking (all methods including infra-red); AULTONE applied by knife or sprayed, and air dried.
(c) Decorative, protective, heat and cold resistant; for any part suitable for baking.
*See advertisement, Page 23-D*

## B

**Bownes, Frank, Co., Chelsea, Mass.**
(a) MODENE, mill whites and synthetic enamels and special finishes.
(b) For spray, brush and dip; air dried and baked.
(c) Decorative and protective; for machine tools.

**Bradley, C. E., Laboratories Inc., Elm St., Brattleboro, Vt.**
(a) BRADLEY paints, lacquers, enamels, varnishes, and synthetics; available in color.
(b) For brush, spray and dip; air dried or baked.
(c) Decorative, rustproofing, heat resistant; for all types of machines.

## C

**Carpenter-Morton Co., 77 Sudbury St., Boston.**
(a) COMBATIT rust inhibitive primer in greenish gray or darker.
(b) Can be applied by any method; air dried.
(c) Rustproofing of iron and steel; for all machines subjected to more than ordinary moisture conditions.

**Central Paint & Varnish Works, 63-69 Prospect St., Brooklyn.**
(a) CENTRAL synthetic porcelainized machinery finish; CENTRAL machinery enamel; available in colors.
(b) For brush, spray or dip; air dry.
(c) Decorative, rustproofing and cleanliness; for all types of machinery exposed to scrutiny of public.

**Chemical Research Corp., 214 East 19th St., Tulsa, Okla.**
(a) RESISTAL HCL-400, water-clear coating, for metals and alloys.
(b) Brush, spray or dip and dries dust-free in 15 minutes.
(c) Tough, nonpororus, durable, high dielectric strength; applied over rivets, overlaps and other uneven parts of exterior construction of metal aircraft.

**Chromium Corp. of America, 120 Broadway, New York.**
(a) CRODON chromium plating (also copper, nickel, etc.); in metallic colors only except for special processes.
(b) Electroplating.
(c) Decorative, rustproofing, hardness; for various types of machines.

## D

**Day, James B., & Co., 1872 Clybourn Ave., Chicago.**
(a) NITROLITE lacquer enamel; and a synthetic baking enamel.
(b) Lacquer sprayed or dipped and air dried; enamel sprayed and baked.
(c) Decorative; for any type of metal machine part.

**Dibble Color Co., 1497 East Grand Blvd., Detroit.**
(a) DIBBLE standard machinery finishes in gray, black, white and red.
(b) For brushing and spraying; air drying and baking.
(c) Rustproofing; for milling and broaching machines, lathes, presses, etc.

**Di-Noc Mfg. Co., 1700 London Rd., Cleveland.**
(a) DI-NOC lacquer involving special process to reproduce wood grains and other effects.
(b) May be applied to steel, wood and composition material, or furnished in form of prefinished sheets.
(c) Heat, cold and salt spray resistant; for radios, air conditioning units, business machines and similar equipment.

## F

**Felton Sibley Co., Inc., 136 N. 4th St., Philadelphia.**
(a) Machinery paint and enamel; available in color.
(b) For brush and spray; air dry.
(c) Decorative, rustproofing, heat resistant; for machine tools, canning machines, turbines, etc.

**Ferro Enamel Corp., 4150 East 56th St., Cleveland.**
(a) FERRO porcelain enamel; in all colors and shades.
(b) For spray; dip; fire at approx. 1500 degrees Fahr.
(c) Decorative, rustproofing, cleanliness; for food, chemical processing, textile machinery, etc.

## H

**Hague, Alfred, & Co. Inc., 227—34th St., Brooklyn.**
(a) RUBALT No. 269 enamel; available in custom colors.
(b) Can be applied by any method; air dried or low baked.
(c) Rustproofing; for any type of machinery.

**Harrop Chemical Co., 135 Hoboken Ave., Jersey City, N. J.**
(a) HARROP ENAMEL 15 and HARROP ONE HOUR ENAMEL; both available in colors.
(b) Enamel 15 applied by brush and air dried in 15 min.; One Hour Enamel, by brush or spray, and air dried.
(c) Decorative and rustproofing; any type of machine.

**Haynes, C. W., Laboratory Inc., Chandler St., Springfield, Mass.**
(a) LABKOTE synthetic enamel; in any color.
(b) For brush or spray; air dry.
(c) Quick-drying, decorative; for any type of machine.

**Heatbath Corp., Springfield, Mass.**
(a) PENTRATE hot water solution; in black.
(b) For dip or spray (special); air or sawdust dried.
(c) Decorative, rustproofing, friction reducing; for any machine part of steel.

**Heresite & Chemical Co., Manitowoc, Wis.**
(a) HERESITE enamel, in all colors.
(b) Spray, dip, brush; baked.
(c) Acid, alkali resistant, dielectric strength; for any type of machine requiring foregoing characteristics.

**Hilo Varnish Corp., 42 Stewart Ave., Brooklyn.**
(a) HILO paints, lacquers, enamels in all colors; varnish, etc., also Black Japans, and HILO 350 Vitra Carlite in any color, also protective coatings to meet government specifications.
(b) Hilo paints, etc. applied by any method; 350 Vitra Carlite by spraying and dipping.
(c) Paints are used for decoration and rustproofing for all types of machines; 350 Vitra Carlite for decorative and rustproofing purposes on any machine where finish is to withstand 350 degrees Fahr.

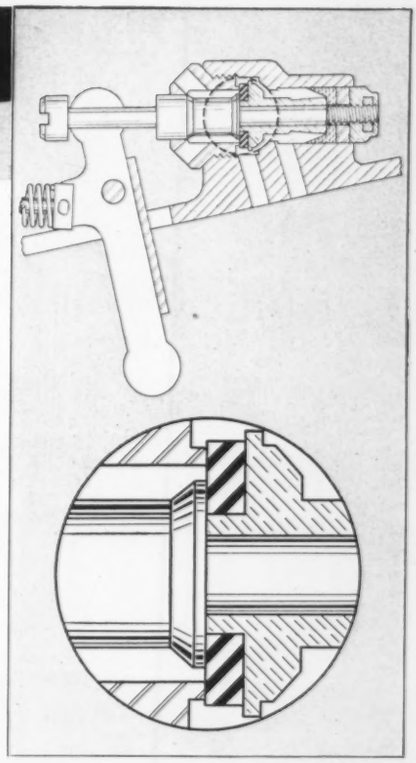
**Hommel, O., Co., 209 Fourth Ave., Pittsburgh.**
(a) HOMMELAYA process of vitreous enameling in any color or shade.
(b) For spray or dip; drier equipment.
(c) Decorative, rustproof or heat resistant; for any type of machine.

**Hooker Glass & Paint Mfg. Co., 651 Washington Blvd., Chicago.**
(a) KING machine and engine enamel available in color; No. 6132 standard machine tool gray enamel.
(b) For brush or spray; air dry.
(c) Decorative, protective; King enamel for gas engines, steam engines, presses, machine tools, dynamos, etc.; No. 6132 for woodworking and metalworking machinery.

## I

**Illinois Bronze Powder Co., 2023-2029 S. Clark St., Chicago.**
(a) ILLBRONZE BRAND chrome finish aluminum paints, available in silver chrome (varnish base).
(b) For brush, spray, flow or dip; air dried or baked.
(c) Decorative, heat resisting, rustproofing; on any type machinery.

# CASE HISTORY No. 233 FROM OUR CORPRENE FILES



**PROBLEM: To develop a Grease Gun Valve Seat that would resist oil and aging . . . withstand repeated heavy impact.**

THE manufacturer of a grease gun had to find a valve seat material with unusual qualities. The spool-type valve in his air motor assembly needed a seat which would resist oil and grease, yet be resilient enough to provide a tight seal. It also had to have low set characteristics to recover from a repeated impact of 800 lbs. per sq. inch. Furthermore, it was essential that the seat retain these properties over a long period of time. Almost every material on the market was tried. Some swelled, some flaked out and delaminated, some were pounded out of shape. All failed.

*Solution*

Then a "tailor-made" Corprene compound was tried. Breakdown tests were started, and after 6 hours of continuous operation at 500 strokes a minute the Corprene valve seat was still functioning efficiently. As this was the estimated life of lubricating 9,000 cars, the test was interrupted. Corprene was obviously the satisfactory solution and was adopted.

*A Corprene for your problem*

Corprene—the trade name for a group of cork-and-synthetic-rubber compositions—is available in more than two dozen *standard* compounds, in sheet, cut, extruded, and molded form. In addition, special Corprenes may be compounded—"tailor-made" with physical properties controlled to meet specific requirements. The valve seat in this case history is a typical successful application of one of these *special* Corprenes. Perhaps you have an "unsolvable" sealing problem or another problem that Corprene might solve. If so, tell us about it. Write to Armstrong Cork Company, Industrial Division, 907 Arch St., Lancaster, Pennsylvania.

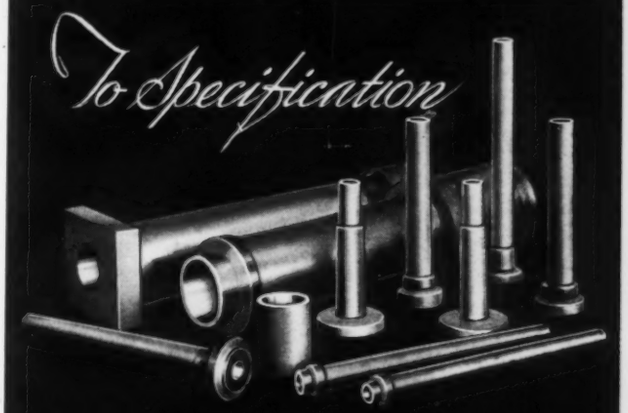


## *Armstrong's* CORPRENE

**COMPOSITIONS OF CORK AND SYNTHETIC RUBBER**

# HOLLOW

*To Specification*



# BORING

AMERICAN HOLLOW BORING CO., --- ERIE, PA.

**Indium Corp. of America, 805 Watson Place, Utica, N. Y.**
(a) INDIFUSED Indium, silver luster finish.
(b) Plating and diffusion.
(c) Wear and corrosion resistant, decorative finish for nonferrous metals for all types of household, office, industrial, electrical, etc., machines.
*See advertisement, Page 85-D*

**Irvington Varnish & Insulator Co., Inc., 6 Argyle Terrace, Irvington, N. J.**
(a) HARVEL; available in all standard colors.
(b) Applied by brush.
(c) Decorative, acid and alkali resistant, heat resistant; for pumps, electric motors, etc.

## J

**Johnson, S. C., & Son Inc., Racine, Wis.**
(a) WAX-O-NAMEL, combination of synthetics, wax and color pigments; available in 19 shades and standard machine tool gray. CAVEL finish, combination synthetics, bronze powder and color pigments; in gunmetal gray, brown, blue, copper, gold and other metallic effects.
(b) Wax-O-Namel applied in all methods; air dried, low heat slow bake, high heat short bake. Cavel sprayed and splattered for hammered effect . air dried or baked.
(c) Both decorative, protective, heat and oil resistant; for all types of machinery.

## K

**Koppers Co., Tar and Chemical Div., Pittsburgh.**
(a) KOPPAX paint in black only; LOCOMAX paint in black or dark gray.
(b) Locomax sprayed or brushed, Koppax brushed only.
(c) Koppax used for damp-proofing, rustproofing, heat resistance, corrosion resistance; for industrial machinery, etc. Locomax is used for decorative and rustproofing purposes in railway locomotives.

**Krome-Alume Inc., 241 Bewley Bldg., Lockport, N. Y.**
(a) KROME-ALUME plated aluminum finish.
(b) For plating.
(c) Decorative, rustproofing; in any type of machine.

## L

**Lehon Co., 4425 South Oakley, Chicago.**
(a) MULE-HIDE asphaltic aluminum paint, in aluminum only.
(b) For brush, spray, dip; air dry.
(c) Decorative and rustproofing; used on woodworking or metalworking machines.

**Liquid Plastic Corp., 4150 East 56th St., Cleveland.**
(a) VEDOC synthetic finish; available in black and white only.
(b) For spraying and dipping; baked.
(c) Decorative and protective; for washing machines, refrigerators, etc.

## M

**Maas & Waldstein Co., 438 Riverside Ave., Newark, N. J.**
(a) METALUSTRE lacquer enamels and synthetic enamels available in 28 standard colors; RAYDUR synthetic enamels in most colors; DUART WRINKLE enamels in most colors; CODUR enamels in colors; and DYKAST lacquer enamels in most colors.
(b) Metalustre, spray, air dry and bake; Raydur, spray or dip, bake (Infra-red) ovens; Duart, spray; Codur, spray or dip; and Dykast, spray and dip, air dry.
(c) Decorative and protective coatings; Metalustre is used for sheet metal work and castings; Raydur on any machine requiring a tough, durable finish; Duart for cabinets and metal or Bakelite parts that can be baked; Codur for any type of machine requiring moisture and chemical resistant finish; and Dykast for zinc and aluminum die castings.

**McDougall-Butler Co. Inc., Buffalo, N. Y.**
(a) HARDCOTE synthetic finishes in over 30 color combinations, gold and aluminum; also varnishes, enamels, and paints.
(b) Brush, spray or dropper method; and dries dust-free in 15 minutes and hard in one hour.
(c) For inside or outside surfaces of wood, metal or plastics; corrosion resistant.

**Monsanto Chemical Co., Merrimac Div., Everett Sta., Boston.**
(a) MERTEC and R-4000; both lacquers available in color.
(b) Both applied by spray or brush; air dried.
(c) Corrosion resistant; for chemical plant machinery, laundry and mill machinery, etc.

**Murphy Varnish Co., 224 McWhorter St., Newark, N. J.**
(a) VITRALYN enamel and SHRIVEL FINISH enamel, both available in color.
(b) Both spray or dip; baked (high heat-short bake for Vitralyn also).
(c) Vitralyn is for decorative and protective purposes, for castings, stampings, office equipment, machine tools, and general machinery. Shrivel Finish is decorative for office equipment, machine tools, castings and stampings.

## N

**New Jersey Lacquer Co. Inc., 4400 Dell Ave., North Bergen, N. J.**
(a) PYROLAC lacquers, synthetic coatings; available in all colors.
(b) For spray, dip, brush; air dry and bake.
(c) Decorative, heat resistant, rustproofing; for cinema projectors, cameras, typewriters, scales, electric instruments, etc.

**New Wrinkle Inc., Dayton, O.**
(a) WRINKLE enamel in all colors.
(b) Applied by spraying; oven or Infra-red dried.
(c) Decorative and protective; for all types of machines.

## O

**Oakley Paint Mfg. Co., 727 Antonia St., Los Angeles.**
(a) BATEX synthetic enamel in all colors; OIL TOOL LAKKER, synthetic lacquer, in all colors.
(b) Batex, spray or dip and air dried or baked; Oil Tool Lakker, brush, spray or dip and air dried in 15 min.
(c) Batex is wear resistant for machines requiring high grade finish; Oil Tool Lakker is quick-drying, durable finish used on any machine but mostly in oil fields.

## P

**Parker Rust-Proof Co., 2177 East Milwaukee, Wis.**
(a) PARKERIZING and BONDERIZING.
(b) Spray or dip; force drying.
(c) Rustproofing and as a base for paint, lacquer, enamel and oil finishes; for all types of machines and equipment.

**Peninsular Paint & Varnish Co., 8250 St. Aubin Ave., Detroit.**
(a) KLEEN-EZY and PENPROX, paint, varnish, enamel and lacquer; in all colors.
(b) For brush, spray or dip; air drying or baking.
(c) Decorative, rustproofing, heat resisting, etc.; for all types of machinery.

**Pittsburgh Plate Glass Co., Industrial Paint Div., Grant Bldg., Pittsburgh.**
(a) Pittsburgh industrial finishes; paints, varnishes, lacquers and special process finishes to manufacturers specifications.
(b) Suitable for all methods of application.
(c) Decorative and protective finishes for all types of machines.

**Porcelain Enamel & Mfg. Co., Eastern & Pemco Ave., Baltimore.**
(a) PEMCO porcelain enamels, in any color.
(b) For spray and dip; continuous dryer.
(c) Decorative and rustproofing; for all types of machines.

**Porcelain Metals Inc., 28-20 Borden Ave., Long Island City, N. Y.**
(a) SUPORCEL porcelain enamel.
(b) For spraying; hot air, then firing at 1550 degrees Fahr.
(c) Decorative, where sanitation and easy cleaning is required.

**Pyrene Mfg. Co., 560 Belmont Ave., Newark, N. J.**
(a) UDYLITE, cadmium finish, in silvery-white; PYRENE BRIGHT ZINC in silvery white; PYRENE BRIGHT NICKEL, thick deposits of high brilliance; BONDERITE, in grey paint base; PYRENE CHROMIUM; ALUMILITE; PARKERIZING, silvery to variety of black finishes.
(b) Udylite, Pyrene Bright Zinc, Bright Nickel and Chromium plating; Bonderite, immersion; Alumilite, electrolytic; Parkerizing chemical displacement without changing dimensions or physical characteristics.
(c) Udylite for rustproofing and decoration of machines with steel parts subject to rusting; Pyrene Bright Zinc for protection on variety of machines. Pyrene Bright Nickel for decoration, protection and base for chromium plating. Pyrene Chromium for decoration, rustproofing and wear resistance on machines having decorative parts or requiring longer life of parts subject to wear. Bonderite for rustproofing of machines with steel parts. Alumilite for decoration and protection of machines having aluminum parts. Parkerizing for rustproofing and decoration of machine parts.

## R

**Reilly Tar & Chemical Corp., 1615 Merchants Bank Bldg., Indianapolis.**
(a) RESISCOTE paint, in gray, etc.
(b) Brush or spray; air dried or baked.
(c) Rustproofing, protection against corrosive gases, etc.; for all types of machines.

**Roxalin Flexible Lacquer Co., 806 Magnolia Ave., Elizabeth, N. J.**
(a) ROXAPRENE synthetic enamel, in all colors; RINCONTROL wrinkle enamel, in practically all colors.
(b) For spraying and dipping; Rincontrol only for spraying.
(c) Both are decorative and corrosion resistant; Roxaprene used for air conditioning equipment, etc.; Rincontrol used for business and electrical appliances.

## S

**Sherwin Williams Co., 101 Prospect Ave., Cleveland.**
(a) KEM ENAMELS; also paints, varnishes and lacquers to suit individual requirements, and heat resistant finishes.
(b) Brush or spray; air drying or baking.
(c) For application to all types of machines. KEM ENAMELS save finishing time; 4 or 5 coats can be applied in 6¼ to 9 hrs.

**Simoniz Co., 2100 Indiana Ave., Chicago.**
(a) COROL semi-hard removable anticorrosive.
(b) For spray, dip, brush; air dried, non-oxidizing.
(c) For rust and corrosion prevention of all types of machines.

**Superior Metal Works, 66th Place at S. Oak Park, Chicago.**
(a) SUPERIOR chrome, nickel, brass and copper plating in bright and satin-plated finishes, striped or crimped to a variety of patterns.
(b) Plating.
(c) For decorative purpose in office, domestic machines, etc.

## T

**Triskalite Corp., 67 Wall St., New York.**
(a) TRISKALITE chromium plating; available in a silvery white color, devoid of usual blue cast.
(b) Plating.
(c) Rustproofing, wear resistance, decorative, heat resistance, etc.; used wherever chrome plating is desirable.

**Tropical Paint & Oil Co., 1276 West 70th St., Cleveland.**
(a) TROPELITE varnish (100 per cent Bakelite), available in clear, black and gray; A.C.B. primer and finishing coats in red, gray, and black.
(b) Tropelite can be applied by any method and is air dried; A.C.B. by brush or spray, also air dried.
(c) Tropelite is alkali, acid and moisture-proof and A.C.B. is a rustproofing and decorative coating; both can be used on all kinds of machinery.

## U

**United Chromium Inc., 51 E. 42nd St., New York.**
(a) UNICROME alkaline copper plating.
(b) Plating.
(c) Smooth, lustrous; for decorative purposes.

**United Platers Inc., 991 Madison Ave., Detroit.**
(a) UNIMATIC chrome, nickel, copper, cadmium, tin, zinc, lead, brass, bronze, stainless steel, aluminum, etc., finish.
(b) Plating, dipping, tumbling, hot lead casting, parkerizing, natural and oxidized finishes.
(c) Decorative, rustproofing, wear and heat resistant; for use on all kinds of machines.

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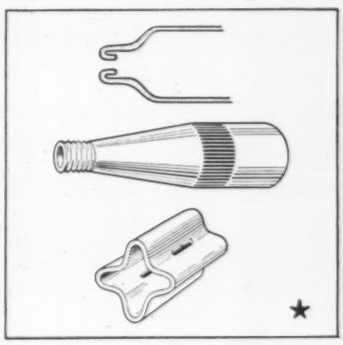
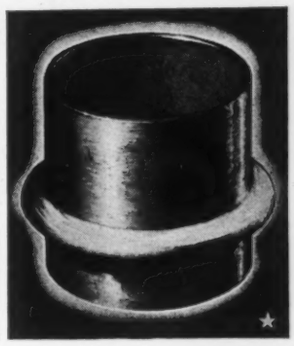
★ A *Natural* FOR ★

# SPEEDING DEFENSE PRODUCTION





**PRODUCTION** of stainless parts for defense applications is being speeded by this Welded Stainless Tubing because tubing shapes are *natural* design units. They are close to the final part shape, so can be finish formed by flanging, expanding, tapering and spinning operations—with a minimum of machining.

Then, too, there are the *natural* advantages of using this Stainless. It provides easy forming and none of the valuable metal need be machined away. Hollow, thin-wall Welded Stainless Tubing parts are now often able to carry loads formerly assigned to solid machined bars or heavy-wall carbon steel tubing.

Through supplying this easier-to-fabricate tubing, Carpenter is helping to speed defense production in hundreds of plants. At the same time, the Carpenter Welded Stainless Tubing Manual keeps production and engineering departments informed on further time-saving methods in fabrication. If you do not already have a copy, send for one today.

**THE CARPENTER STEEL COMPANY**
WELDED ALLOY TUBE DIVISION
**KENILWORTH, N. J.**

*Carpenter*
**WELDED**
**STAINLESS TUBING**